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GUAM AGRICULTURAL EXPERIMENT STATION,
C. W. EDWARDS, Animal Husbandman in Charge.

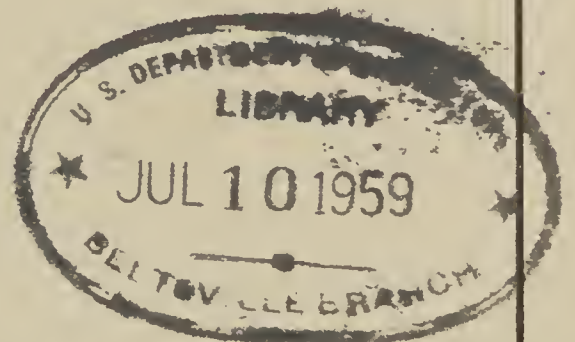
Under the supervision of the STATES RELATIONS SERVICE,
Office of Experiment Stations, U. S. Department of Agriculture.

REPORT OF THE
GUAM AGRICULTURAL EXPERIMENT
STATION.

1919.

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Issued February 17, 1921.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1921.

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C. W. EDWARDS, Animal Husbandman in Charge.**

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GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM.

[Under the supervision of A. C. TRUE, Director, States Relations Service, United States Department of Agriculture.]

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LETTER OF TRANSMITTAL.

GUAM AGRICULTURAL EXPERIMENT STATION,
Island of Guam, March 19, 1920.

SIR: I have the honor to transmit herewith a report of the Guam Agricultural Experiment Station, 1919.

Very respectfully,

C. W. EDWARDS,
Animal Husbandman in Charge.

Dr. A. C. TRUE,
*Director, States Relations Service,
U. S. Department of Agriculture, Washington, D. C.*

Publication recommended.

A. C. TRUE, *Director.*

Publication authorized.

E. T. MEREDITH, *Secretary of Agriculture.*

CONTENTS.

	Page.
Report of the animal husbandman in charge.	5
Summary of work of the year.	5
Agronomy.	6
Horticulture.	7
Animal husbandry.	8
Extension work.	9
The Guam Industrial Fair.	10
Animal husbandry.	11
Cattle.	11
Swine.	13
Goats.	17
Chickens.	17
Report of the agronomist and horticulturist.	20
Agronomy.	20
Forage-crop investigations.	23
Grasses.	23
Sorghums.	26
Legumes.	27
Root crops.	29
Drying and storing seed and food products.	30
Cotton.	31
Corn.	31
Rice.	32
Green manure and cover crops.	34
Tobacco.	34
Soils.	35
Improved farming methods.	37
Horticulture.	38
Tropical fruit investigations.	38
Garden vegetable demonstrations.	39
Seed and plant distribution.	41
Coconuts.	41
Bananas.	43
Coffee.	44
Report of the extension agent.	44
Introduction.	44
Farming conditions in Guam.	45
Adult demonstration work.	47
School gardens.	48
Boys' and girls' club work.	49
Meteorological observations, 1919.	50

ILLUSTRATIONS.

	Page.
PLATE I. Half-blood Ayrshire heifers (one-half Ayrshire, one-half native).....	12
II. Fig. 1.—Grade boar, seven-eighths Berkshire, one-eighth native. Fig. 2.—Grade gilts, seven-eighths Berkshire, one-eighth native..	16
III. Fig. 1.—Native pigs, showing comparative growth when kept tied and when allowed to run on pasture. Fig. 2.—Half-bred doe, one-half Toggenburg, one-half native.....	16
IV. Fig. 1.—Field of Para grass in which velvet beans are growing. Fig. 2.—Test plats of cowpeas during dry season	24
V. Fig. 1.—Grain sorghums. Fig. 2.—Broom corn and sweet sorghums.	24
VI. Types of farm implements gradually being adopted by Guam farmers..	36
VII. Fig. 1.—Spike-tooth harrow. Fig. 2.—Disk harrow cutting velvet beans. Fig. 3.—Varieties of tomatoes.....	36

REPORT OF THE GUAM AGRICULTURAL EXPERIMENT STATION, 1919.

REPORT OF THE ANIMAL HUSBANDMAN IN CHARGE.

By C. W. EDWARDS.

SUMMARY OF WORK OF THE YEAR.

The work of the station during the year was seriously interfered with by the typhoon of July 6, 1918, and the heavy rains which fell for three months following; the influenza epidemic; a drought of about six months' duration; and by inability, due to the lack of transportation, to secure breeding stock, seed material, and other supplies at times when they were urgently needed.

The typhoon or hurricane which occurred on the morning of July 6 was the first serious storm to visit the island since November, 1900. Most of the growing crops at the station as well as those scattered over the greater part of the island were ruined. Station buildings were considerably damaged and much of the fencing was destroyed. Many of the light-material native houses of the island were practically destroyed and a number of the more permanent structures more or less damaged. In some districts the coconut trees were apparently uninjured, while in other sections many were either killed or severely damaged. It is estimated that of the total number of bearing trees on the island, one-fourth were killed or else so badly damaged that two or three years will be required for them to completely recover.

After the typhoon the food situation became particularly acute because of the lack of transportation due to war conditions. Since the outbreak of the war, food production had constituted one of the chief lines of station work. Consequently, efforts had to be redoubled to produce quick-growing crops, and every assistance possible had to be given the people to mitigate conditions. Increased amounts of imported seeds were distributed in addition to large quantities of seed material, especially cowpeas and beans, and plants grown at the station.

The island corn that was mature at the time of the typhoon was gathered, dried, and stored at the station, and later distributed to the public for seed purposes.

AGRONOMY.

In agronomic investigations, the principal work of the year was carried on with forage crops, legumes, corn, and soils. In the work with forage crops the total yield of green forage from Para grass fields was greatly increased by planting cowpeas and velvet beans in among the grass. A comparison of the residual effects on the yield of Para grass of various commercial fertilizers, barnyard manure, and the practice of renovation by plowing showed the barnyard manure to give the most lasting results, and certain of the commercial fertilizers to rank second in this respect. *Paspalum dilatatum* showed its great drought-resistant qualities during the six-month drought period. About 20 acres was cleared at the Cotot stock farm and about 8 acres at the Piti station preparatory to planting this grass during the coming rainy season. In a grain sorghum test with a number of varieties of kafir, feterita, and milo, feterita and yellow milo matured the earliest, while Dawn and Blackhull gave the best yields of any of the kafirs. Orange sorghum showed the highest yields in a variety test of sweet sorghums. A legume test was conducted in which the yields of Canada field peas, mungo, soy, jack, and velvet beans, and several varieties of cowpeas were compared. The field peas and soy beans were failures. The cowpeas demonstrated their superiority over the other legumes as a dry-season crop. The Buff and Large Blackeye were the earliest to mature of seven varieties of cowpeas, but were light yielders. Iron and Brabham seemed well adapted for use as cover crops, but the New Era and Whippoorwill appeared the best suited for all purposes of any of the varieties. Several varieties of legumes were compared to determine their efficiency as cover crops. Cowpeas gave the best results of any during the extreme dry season, while velvet beans were the most satisfactory the remainder of the year, including the rainy season. Jack beans covered the ground fairly well and were the only legumes in the test to withstand the effects of the typhoon. Canada field peas and soy beans made a very poor showing. Continued tests have shown that under ordinary conditions velvet beans make one of the best cover and green-manure crops for Guam because of the heavy growth of vine and the comparatively long period the crop efficiently covers the ground.

The ear-to-row breeding work with corn has been continued up to the tenth generation. Certain characters, such as dwarfness of stalk, one ear to stalk, and early maturity, are now apparently fairly well fixed, but the yield seems to have decreased.

Fertilizer experiments with rice showed in general that applications of phosphorus produced the best yields. Early plantings of the crop were the only ones that escaped serious injury from the rice bug

of India. In connection with the tobacco work, the native practice of hand worming, as a means of controlling the very prevalent tobacco worm and other insect pests, was compared with that of controlling by means of a lead arsenate spray. The latter method gave the higher total weight of leaves, as well as the greater number of first-class leaves per plat, while the difference in cost was slightly in favor of the hand worming.

In continuation of the study to determine the cause of the low productivity of certain newly broken grasslands, various pot and field tests were carried on. A number of different crops were grown on old soil, on that of newly broken grassland, and on soil where the land had been under cultivation for about 18 months. Although the chemical and mechanical analyses showed the soils to be practically of the same composition, a great difference was observed in the yields of the crops grown upon them, with the exception of rice and cowpeas. This difference was less in the second than in the first crop. A pot test was also carried on for the purpose of comparing the value of certain commercial fertilizers with that of various local fertilizer products when applied to old and newly-broken grasslands. Lime on the old and bat guano on the new soil gave very good results, while manure proved very beneficial to both soils. Certain combinations of acid phosphate with other commercial fertilizers gave fairly good results, as did also seaweeds and ashes of coconut husks.

In the investigations dealing with the preservation and storage of food products, successful methods were devised for preparing, drying, and storing sweet potatoes, bananas, beans, taro, and breadfruit.

HORTICULTURE.

In some respects the damage done by the typhoon was more serious to the horticultural than it was to the field crops of the island. Most of the quick-growing field crops can be replaced within a short time, while it will take a number of years to repair the damage done to many classes of fruit trees, including the coconuts.

It was necessary to replant the papaya, pineapple, and banana plats. The only new horticultural work begun during the year was the establishment of a native citrus orchard. Special attention was given to tomato growing, seed and plant distribution, and to coconuts. In the tomato variety test the Cristobal, introduced into Guam from the Caroline Islands, and a Hawaiian hybrid variety appear the most promising. Varieties grown from seed obtained from the States have produced the largest fruits, but have not been sufficiently prolific to warrant their cultivation. The fertilizer experiments at Cotot and Tarague have been continued. At Cotot the trees in the unfertilized plats, which have been kept free of grass,

show a better growth than those in the fertilized plats, where the grass was given full sway except just around the trees.

A test was carried on in the making of copra from nuts in different stages of maturity. The shrinkage in drying varied from 25.26 per cent to 72.03 per cent, depending upon the degree of ripeness of nut. Nuts that had just sprouted gave the highest yield of copra, but the product was inferior in quality to that of the copra made from mature nuts, which gave the second highest yield. The common Chamorro practice of cutting the meat out of the shell when the nuts are first split open gave a somewhat better grade of copra than was secured by allowing the meat to remain in the half shell until loosened by becoming partly dry. Samples from this series of copra-making experiments were arranged as an educational exhibit and shown at the Guam Industrial Fair.

ANIMAL HUSBANDRY.

The general lines of animal husbandry work outlined in previous reports were maintained during the year. In the main these projects comprise (1) the work of establishing improved station breeding herds of the various classes of animals; (2) the production and distribution of improved breeding stock to the ranchers of the island; and (3) the conducting of feeding, breeding, and other tests.

Under the cattle project the work of establishing an improved station herd through the use of Ayrshire blood was continued at the Cotot stock farm; comparative milk records were made, and preliminary feeding and other tests were conducted with the few pure-blood and grade cows kept at the Piti station; and the work of improving the cattle of the island was furthered by offering free of charge the services of the station sires at Piti, and by the stationing of grade sires in various districts of the island.

In the work of improving the native swine, 1 grade Berkshire boar, 10 grade sows, and 23 grade pigs were sold to the public for breeding purposes. A test was carried on to show the advantages of allowing pigs to range in pastures rather than of keeping them secured by the fore leg, as is the common practice among the Chamorro farmers. A local ration of corn meal, cowpea meal, and cooked sweet potatoes gave better results as a feed for growing pigs than an imported ration of corn meal, ground oats, and meat scrap. In a preliminary test, velvet beans when fed to pregnant brood sows seemed to produce ill effects in the offspring.

The work of improving the station goat herd and producing breeding stock for sale was furthered by the use of grade Toggenburg bucks. Eight grade bucks and 7 grade male kids were sold to the public.

Owing to the inability to secure new stock until the latter part of the hatching season, breeding work with chickens was confined

largely to the production of stock for sale and for use in feeding tests. A series of tests was carried on to determine the value for chicks from 1 to 12 weeks of age of fresh-grated coconut when fed as a supplementary ration after a portion of the oil has been extracted by the Chamorro custom of hand squeezing. Various proportions of the coconut were fed in conjunction with a ration of mixed grains. Good results, especially with chicks over 3 weeks of age, were obtained by the addition of the coconut to the regular grain ration in amounts not exceeding 30 per cent of the total ration. When more than this amount was fed ill results followed.

In two other tests rations composed of locally-grown grains, hand-squeezed coconut, and a small amount of meat scrap were compared as a feed for growing chickens from 6 to 12 weeks of age with standard rations made up of imported grains and meat scrap. In test No. 1 the local ration consisted of cracked corn, cracked rice, cracked cow-peas, hand-squeezed coconut, and a small amount of meat scrap, while in test No. 2 the native ration consisted of equal parts of cracked corn and the coconut with meat scrap in the self-feeders. In both tests the check lot received a standard dry mash and scratch mixture. In each case the lot of chickens receiving the rations made up of imported grains and meat scrap made somewhat better gains than the lot receiving the local ration.

EXTENSION WORK.

W. J. Green, a graduate of the Oklahoma Agricultural and Mechanical College, formerly employed in extension work in that State, was appointed as extension agent of the station on January 25, 1919. He arrived in Guam to assume the active duties of his position on March 28, 1919.

The filling of this position meets an urgent need of the station. In former years considerable extension and demonstration work was carried on by the distribution of seeds and plants, by the production and distribution of improved breeding stock, by advocating the general use of improved farming methods and implements, by encouraging farmers to visit and inspect the work of the station, and by visits of the station staff to the ranches of the various districts. However, it has long been realized that the proper development of the extension work necessitates the organization of a separate department whose employees will be able to give the matter their entire attention. It is impossible for members of the staff having charge of the regular station duties to give the field work the close personal supervision necessary when dealing with the Chamorro farmer. It has been difficult to get the farmers of the outlying districts to visit the station, the Chamorro people being naturally clannish and remaining close to their respective districts.

The extension work of the station has been outlined to include adult demonstrations, boys' and girls' club work, and school gardens. By the close of the year adult demonstrators had been selected for the raising of the various classes of live stock and farm crops; the school-garden work, conducted in cooperation with the Department of Education, was well under way; and the boys' and girls' clubs had been organized to include six lines of work, namely, the production of corn, copra, taro, beans, pigs, and poultry.

THE GUAM INDUSTRIAL FAIR.

The Guam Industrial Fair is fast becoming an established institution of the island. The initial fair in 1917 proved a new idea to the Chamorro people, whose interest in the event is not only rapidly growing but promises to be of great assistance in the work of developing the agricultural resources of the island.

The third annual fair was held July 3, 4, and 5, 1919, just after the close of the fiscal year covered by this report, but mention is made of it at this time because most of the work for the event was done prior to July 1.

In view of the long drought, which prevailed the latter half of the year, the agricultural exhibits presented were surprisingly numerous. In addition to the general or individual entries, a collective exhibit was put on by each district. This community contest was a new feature but was attended by such success that its exhibits no doubt will form an important part of each succeeding fair. The exhibits attracted a great deal of attention and the contest was a means of arousing considerable competition among the different districts. The first prize was won by the municipality of Merizo, with Inarajan a close second.

As copra is the chief money crop of the island, the largest money prizes in the agricultural department were offered for entries of this product in order to encourage the making of better grades. The exhibits presented showed that as good copra can be made in Guam as any place in the world.

The agricultural exhibit of the experiment station included, besides the general collection of fruits, vegetables, and other crops, a display of copra, dried food products, fibers, and an apiarian exhibit. Samples of copra made from nuts at different stages of maturity emphasized the importance of selecting and using only well-matured nuts. The dried food products showed the feasibility of preserving supplies of such important crops as taro, sweet potatoes, breadfruit, and bananas. The bee and honey exhibit included bees at work in observation hives, samples of honey and wax, and various kinds of modern beekeeping supplies and appliances. The fiber collection consisted

of 33 kinds of fibers prepared from plants grown in Guam and suitable for the making of cloth, rope, nets, baskets, and other articles.

In the live stock department, with the exception of the swine division, the exhibits showed decided improvement over those of last year, both as to number and quality of entries presented. The classes of native carabaos, native bulls and bullocks were made up of especially good type individuals. An encouraging feature was the increase over the two former fairs in the number of improved or crossbred swine and chickens entered, the result of the work of the station in upgrading the native stock of the island.

A section of the live stock building was given over entirely to the experiment station exhibit, which was arranged with the main idea of displaying comparisons between the improved and the native animals of the various classes, object lessons which showed what can be accomplished by selection and the use of better blood. Placards on stalls and pens showed the weight, performance, breeding, and other points of comparison of the different individuals. A group of cows comprised a pure-blood Ayrshire weighing 1,000 pounds and giving a daily milk yield of 22 pounds; a grade (one-half Ayrshire, one-half native) weighing 800 pounds and yielding 12 pounds of milk daily, and an average native cow whose weight was 450 pounds, the average daily milk production of such cows probably not exceeding 4 or 5 pounds. Pens of grade and native hogs offered a striking demonstration of the superiority in size and conformation of the Berkshire crossbred over the native animal. Half-blood (one-half Toggenburg and one-half native) bucks and does, were compared with native goats of the same age. Coops of pure-blood Rhode Island Red chickens and high-grade crossbreds showed the farmer what may be accomplished by successive matings of the native stock with pure-blood cocks. Among the exhibits in this division were two pens of chickens which showed the results of a feeding test. One lot had been fed for some time on an entire ration of corn, while the other lot received only grated coconut, both being on free range. It was readily noted that those receiving the corn had made a better growth than those which were given the coconut ration.

ANIMAL HUSBANDRY.

CATTLE.

The improvement or upgrading of the native cattle of the island and the securing of data relative to the feeding, breeding, care, and management of pure-blood, grade, and native cattle constitute the main objects of the work under this project. So far in connection with the prosecution of this work Ayrshires are the only pure-bloods that have been introduced by the station.

Most of the station cattle are kept at the Cotot stock farm, which is about 10 miles distant from the Piti station. At this place a herd of native and grade cows is being crossed with pure-blood and grade bulls, the object being to establish ultimately a pure-blood herd and to produce improved stock for experimental work and for distribution to the public for use in upgrading their native cattle.

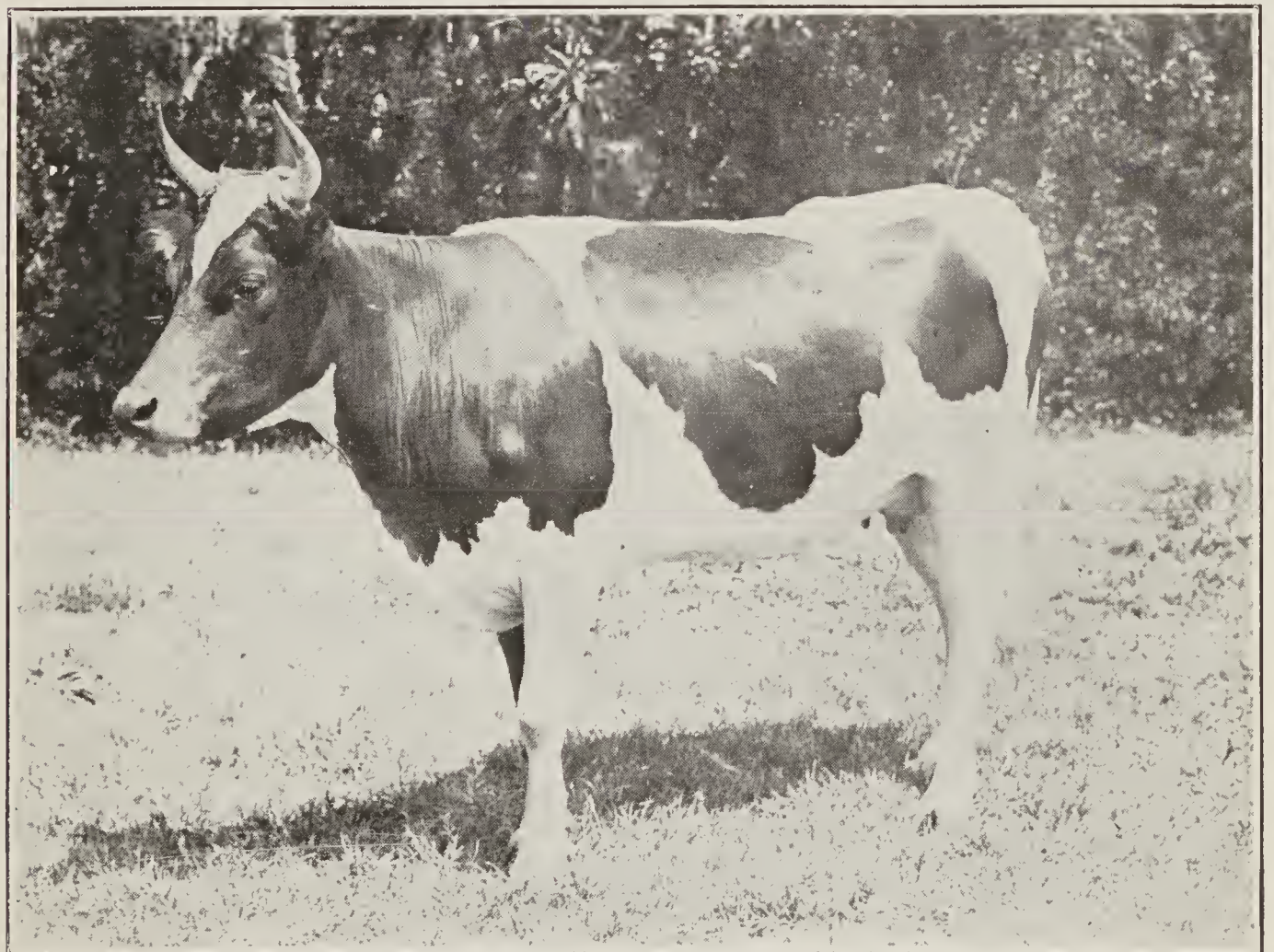
The few pure-blood Ayrshires, sires for public service, and special test animals, such as cows whose milk production records are being taken, are maintained at the Piti station.

Along with the work dealing with the problems of feeding, breeding, and management, records are being kept to determine the comparative size, quality, rate of growth, and adaptability of the imported and locally grown pure-bloods, various classes of grades, and native cattle.

Despite the failure, due to the lack of transportation facilities, to secure additional pure-blood sires and feeds at certain times when most needed, the station work with cattle showed satisfactory progress during the year. The drought, of which mention has already been made, was not nearly so extensive at the Cotot farm and vicinity as it was at Piti and other parts of the island, and sufficient pasturage was had to keep the herd at Cotot in good condition throughout the year. No deaths from disease occurred, though the total loss from other causes comprised four head. The total increase consisted of 22 grade calves.

The Ayrshire bull, John Gray, the only pure-blood sire on hand at present, is still affected by an ailment characterized by a weakness of the hindquarters, as mentioned in the last annual report. However, his condition improved during the year to such an extent that it was possible to use him for light service. The weakness is still such that it has been deemed impracticable to transfer him to Cotot, and it has been necessary to use a grade bull as herd sire at that station. At Cotot one cow and three carabaos have shown symptoms similar to those affecting John Gray. A few other cases have also been noted among the cattle and carabao of the island. As stated in last year's report, pathological specimens from a bull which died of this ailment were sent to the veterinary department, Bureau of Agriculture, Manila, which reported that death was probably due to a slow forage poisoning. A disease that is now present among the carabaos of the Philippine Islands causes a weakness or partial paralysis of the hindquarters, symptoms similar to those shown by the carabaos above mentioned. This disease is said to be caused by a blood parasite found in the posterior aorta.

The imported pure-blood cow Red Rose calved on May 7, 1919, this being her first calf since the year 1912. During this interval, she was hand bred to various sires and given various treatments but failed to get with calf until turned out on range with a grade bull.



HALF-BLOOD AYRSHIRE HEIFERS (ONE-HALF AYRSHIRE, ONE-HALF NATIVE).

Three grade bulls, other than the sires kept at Piti for public service, were loaned out to individual ranchers.

Data collected relative to milk production show that the Ayrshire grades are a decided improvement over the average native cow. (Pl. I).

Feeds and feeding.—Owing to the lateness of the passage of the appropriation bill, it was impossible, with the small labor force available, to extend the improved pasture areas during the rainy season at Cotot and the Piti station, as planned. During the dry season about 35 acres of woodland at Cotot were cleared, burned, and prepared for planting to Para and Paspalum the coming rainy season, and about 10 acres at Piti have been prepared for planting to Paspalum.

At the Piti station a drought extending from about January 1 to June 15 caused a shortage of green forage, especially during the months of April, May, and the greater part of June. During this period the pastures were supplemented with cowpea vines, breadfruit leaves, and rice straw. At the Cotot stock farm conditions during the ordinarily dry season were not serious, as the longest drought period was of only three weeks' duration.

The Paspalum at Piti showed its drought-resistant properties on the cascajo hillsides where a little growth was noticed even when the drought was at its worst. The grass at this time seemed to make more growth where it had been pastured than it did where it had not been pastured but had been allowed to make a heavy growth before the beginning of the drought.

The improved pasture areas at Cotot were sufficient only to maintain the herds and did not admit of the carrying on of pasture tests. The additional area at this farm, when planted and ready for pasture, will suffice for the tests and provide for the maintenance of an increased herd for the next two years at least.

In connection with the work with dairy cattle, fresh grated coconut was fed in combination with the various concentrates. Some of the cows did not take readily to the coconut at first but seemed to relish it after once becoming accustomed to the feed. From the results obtained it would appear that small amounts of fresh coconut in combination with other concentrates may be advantageously fed to milk cows.

SWINE.

The native swine of the island are as a rule small in size and very poor in maturing qualities. Pork is relished by the Chamorro people and the demand for swine is greater at all times than the supply. That animals of this class are not raised in greater numbers is due to a general lack of facilities and knowledge of the proper methods of care and management, the prevalence of diseases, and to the fact that

a majority of the local farmers have only small ranches and carry on production on a comparatively limited scale. Cholera appears to be endemic but is less troublesome than certain internal parasites, the most common of which are the kidney, cæcum, and lung worms.

The importations of swine by the station have been confined to the Berkshire breed. These pure-bloods are being crossed with the native types in order that stock for experimental purposes may be produced and distributed throughout the island for use in upgrading the native swine. Feeding, breeding, and management tests are carried on in order to assist in the solution of the many problems confronting the swine raisers of this and other parts of the Tropics.

The work was hampered during the year by the inability of the station to secure pure-blood boars to continue upgrading the herd, which now includes some very good type seven-eighths-blood grades. (Pl. II, figs. 1 and 2.) The work during the period was confined to the production of grade stock for distribution and experimental purposes.

Owing to lack of proper facilities for the growing of swine, the herd at the Cotot stock farm was disposed of so that at present the work under this project is being conducted entirely at the Piti station.

A total of 47 grade pigs was farrowed during the year. One grade boar, 10 grade sows, and 8 male and 15 female grade pigs were sold for use as breeding stock. Disease caused the loss of two grade sows and 13 suckling pigs. The latter succumbed to what appeared to be contagious scours.

Feeds and feeding.—Because of uncertain transportation facilities and the poor quality of seed material received and to crop failures, due to drought, a sufficient amount or variety of feedstuffs with which to conduct the work as planned for the year under this project was not available.

In the maintenance of the station herd a variety of feedstuffs was fed, as it was necessary to utilize any available material that could be fed to advantage. The principal local feeds made use of were velvet beans, cowpeas, coconuts, corn, taro, and sweet potatoes. Generally a sufficient amount of these various materials was not on hand at any one time to enable the feeding tests to be conducted. The velvet bean, both as a pasture and as a grain, apparently is a valuable addition to the list of local swine feeds. When fed dry in the pod, it was eaten readily. The animals evidently had no difficulty in shelling the beans, since the pods were discarded and only the grain was eaten. As a result of the short experience gained during the past year it is not deemed necessary to shell the beans for use as swine feed.

Comparison of pasture and tethering method of handling growing pigs.—The object of this test was to compare the results obtained from the method so commonly practiced among the Chamorro farmers

of keeping their pigs tied under bushes or shade trees, the rope being secured to the fore leg, with the results obtained when the pigs are allowed to run loose on pastures provided with housing facilities.

Eight native pigs, 6 barrows and 2 females, three months of age, were used. The test was begun on May 6, 1918, and concluded on September 6. Four of the pigs, 3 barrows and 1 female, were tied under a camachile hedge, which afforded ample shade and a good shelter of its kind. The other 4 pigs were turned in a pasture of velvet beans and Para grass of about one-fourth acre in area. The supply of velvet beans in the pasture was exhausted by July 1, and from this date on the green forage consisted entirely of Para grass. Otherwise, each lot was given the same treatment and the same amount of feed. From May 6 until July 10 the feed consisted of cooked breadfruit and grated fresh coconut. From the latter date until August 22 the breadfruit was replaced with a small amount of a grain mixture of ground corn and oats and from August 22 until the close of the test the ration consisted entirely of the grain mixture.

The pigs running on pasture made a total gain of 144.5 pounds, while the lot kept tethered showed a gain of only 43 pounds. The two pigs shown in Plate III, figure 1, represent the extreme in each lot.

On account of the severe weather which followed the typhoon of July 6, both lots were kept in the swine brood house for 10 days. During this time the pigs of lot No. 2 were kept tethered, while those of lot No. 1 were kept in pens and given all the Para grass they would consume.

The lot ranging on pasture made very small gains even for native pigs, but it should be noted that the amount of grain or feed given to each lot was determined by the total amount that lot No. 2 would consume. As the pigs of this lot, especially after the first two months or so, showed poor appetites, the total amount of feed consumed by both lots was small. The pigs of lot No. 1 ate their feed readily and showed that they would have consumed considerably more feed had it been given them. This test created a great deal of interest among the farmers who visited the station during the time that the experiment was in progress.

During the period of heaviest rains, from August 1 to September 6, the pigs of lot No. 2 not only failed to show gains, but three of the number actually showed a decided loss of weight. After the test had been in progress for some time, the pigs of lot No. 2 aside from being off feed showed a standing coat and other indications of off condition. Those of lot No. 1 appeared to be in good health throughout the test period.

It is true that as a rule pigs, especially young stock, are not kept tied so continuously as the pigs were kept in this test. Moreover,

the Chamorro farmers, during the period of heaviest rains, often keep the pigs tied under the house or other ranch building. However, it is reasonable to suppose that the ill effects would be proportionate to the extent to which the method was employed, and the results obtained show the advisability, especially for growing stock, of providing ample runs and shelter, particularly during the rainy season.

Velvet beans as a feed for brood sows.—In order to secure data relative to the effect on the offspring of feeding velvet beans to pregnant brood sows, two three-quarter-blood sows were fed dry velvet beans in the pod for a period previous to farrowing. From November 5 until December 1 the sows which were pastured on Para grass were fed a daily ration of 2 pounds of ground oats and 1 pound of velvet beans in the pod, and from the latter date until January 1 the ration of each consisted of 4 pounds of the velvet beans in the pod.

On January 6 one sow farrowed a litter of 8 pigs. The average weight of the litter was below that of other litters of the same breeding. Two of the number were weak and died the second day after birth. The other sow, whose ration from January 1 to date of farrowing consisted of a mixture of ground corn, oats and cowpeas, farrowed a litter of 7 pigs on January 28. Of this number 3 were undersized and weak, dying soon after birth; and 1 was deformed, the hind legs being so crooked that the hocks rested on the ground.

Imported versus local ration for growing swine.—A test extending over a period of 60 days was conducted with 2 lots of 4 native pigs each to compare the value of an imported ration consisting of corn meal 16 parts, ground oats 10 parts, and meat scrap 3 parts, by weight with a local ration consisting of a mixture of 2 parts corn meal and 3 parts ground cowpeas, supplemented with cooked sweet potatoes. The pigs used in the experiment, 6 barrows and 2 sows, were about 4 months of age.

The daily ration of lot No. 1 for the first 32 days of the period consisted of 1 pound per head of the imported ration, while the daily ration of each pig in lot No. 2 during the period consisted of 1 pound of the local mixture of ground cowpeas and corn meal together with 1 pound of cooked sweet potatoes. For the remaining period of the test, the daily ration of lot No. 1 was increased to 1.5 pounds per head, and the daily grain allowance of lot No. 2 was increased to 1.5 pounds per head, the sweet potato portion of the ration remaining the same as during the first period of the test. Both lots were pastured on Para grass during the entire experimental period.

In this test, lot No. 1, or the pigs receiving the imported ration of grain and meat scrap, made a total gain during the test period of 96 pounds, while lot No. 2, or the 4 pigs receiving the local ration of corn meal, cowpeas, and cooked sweet potatoes, made a total gain of 121 pounds.

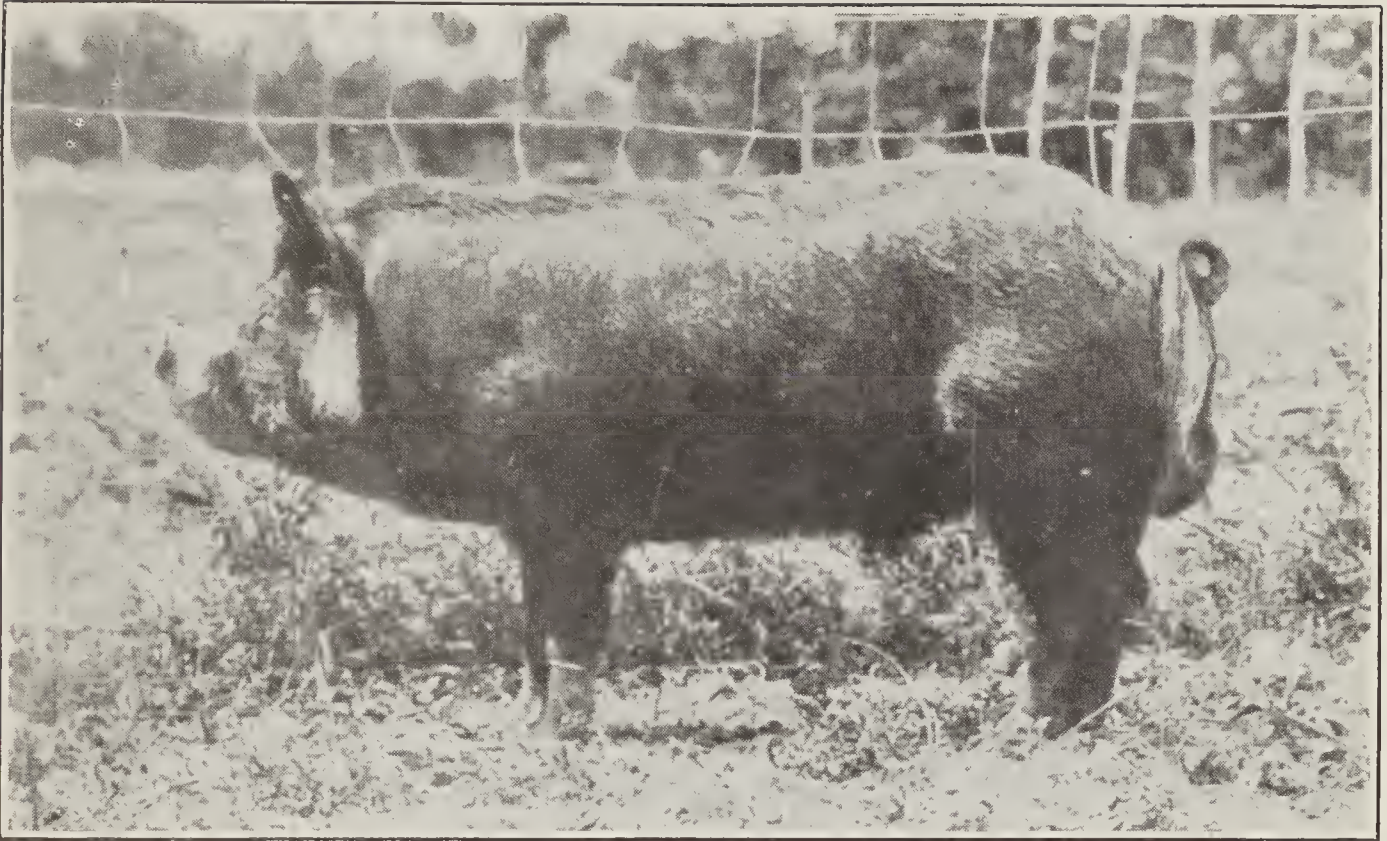


FIG. 1.—GRADE BOAR, SEVEN-EIGHTHS BERKSHIRE, ONE-EIGHTH NATIVE.



FIG. 2.—GRADE GILTS, SEVEN-EIGHTHS BERKSHIRE, ONE-EIGHTH NATIVE.



FIG. 1.—NATIVE PIGS OF SAME AGE, FED THE SAME RATION. ONE TO LEFT KEPT TIED CONTINUOUSLY, ONE ON RIGHT ON PASTURE.

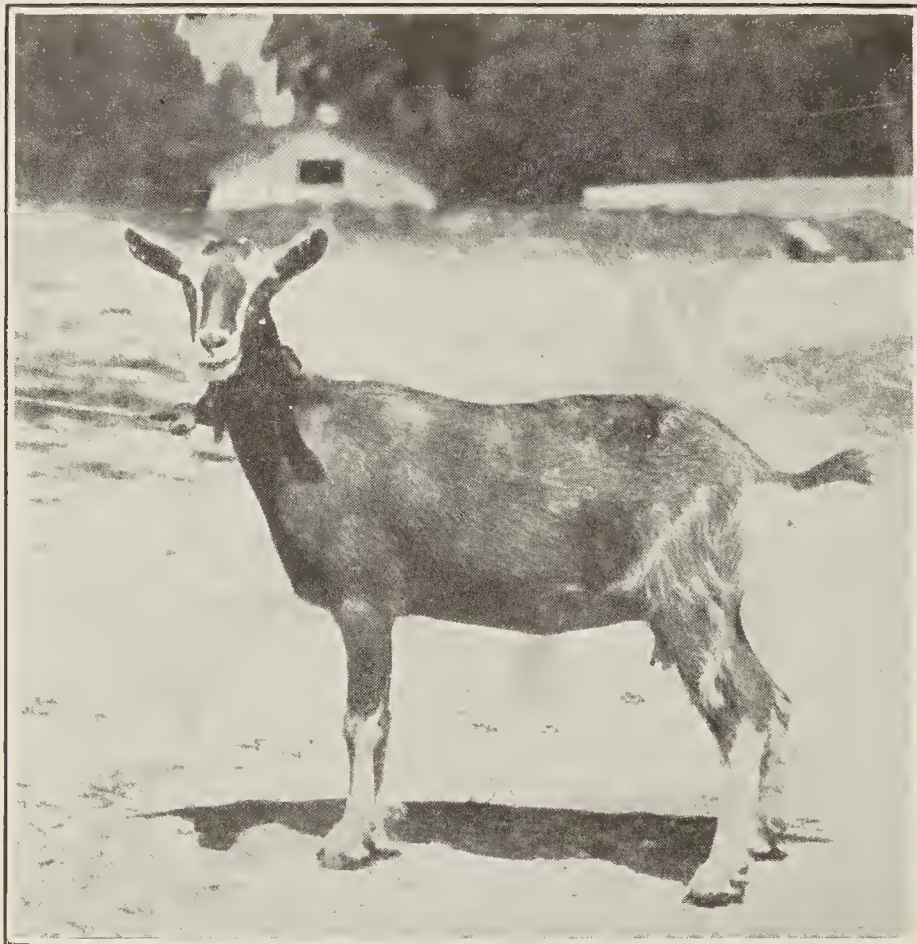


FIG. 2.—HALF-BRED DOE, ONE-HALF TOGGENBURG, ONE-HALF NATIVE.

GOATS.

The work under this project is carried on entirely at the Piti station, where an improved herd of goats is being established from native foundation stock crossed with the Toggenburg. The suitable surplus grade stock is disposed of to the public for breeding purposes.

The most serious obstacles to successful goat raising in Guam seems to be the prevalence of the nodular and fourth-stomach worms and other internal parasites. Where the range is limited and the herd is of considerable size, constant combative measures must be employed against these parasites. The runs should be so arranged as to allow of a three or four months' rotation, and if possible the herd should be given the copper sulphate treatment at the time of each change of pasture. Lice are sometimes troublesome but are readily controlled by the use of the ordinary arsenical cattle-tick dips.

The upgrading work as first planned has been retarded since the death of the pure-blood stud sire in 1916, as the station has been unable to secure any more pure-blood bucks since that time. However, in the meantime the work, with the use of grade sires, has progressed fairly satisfactorily and the station now has on hand a small herd of selected quarter and half blood does. (Pl. III, fig. 2.)

During the past year the herd has been for the most part in good condition, only two deaths occurring from disease. These deaths, however, were due to fourth-stomach worms, which indicates that the herd is not entirely free from the pests despite preventive measures taken. As soon as they were dropped six kids were placed in clean stalls in the barns for the purpose of making further study with the parasites. The dams were milked and the milk fed by hand to the kids. The only other feed given the kids was a little ground grain and grass which was secured from places where no goats or cattle had pastured for several years. At the close of a period of three months one of the kids which appeared to be off condition was posted and found to be quite badly infested with fourth-stomach worms. In this case it would seem that the infection must have been transmitted through the milk which was contaminated from outside sources at milking time.

During the year 8 grade bucks and 7 male grade kids were sold for breeding purposes. The increase during the period consisted of 12 male and 12 female grade kids.

CHICKENS.

Chickens are more generally raised and considered of much greater importance by the average Chamorro farmer than any other class of poultry; in fact, few turkeys and ducks and no geese are found on the island at the present time. For this reason and because of lim-

ited facilities and funds the efforts of the station have so far been confined to various lines of work with chickens. The work is conducted at the Piti station and has consisted principally in a study of the comparative adaptability to local demands and conditions of a number of introduced pure breeds and their various crosses with the native chickens, feeding, incubation, and brooding tests, and the production and distribution of improved breeding stock for use in upgrading chickens of the island.

The native farmer pays this work a great deal of attention, and at no time has the station been able to supply the demand for breeding stock.

Of the various pure breeds introduced the Rhode Island Reds appear best to meet local requirements, and their crosses with the native chickens have proved more satisfactory than any of the other classes of hybrids.

In view of the results of previous work and the present limited facilities, it has been deemed advisable for the present to confine the breeding work to the production of pure-blood Rhode Island Reds and the development of a new breed by crossing the Rhode Island Red with a certain type of native fowl, which will combine the size and egg-laying qualities of the pure blood with the hardiness and other desirable characteristics of the native.

The work of the year has been hampered by the inability of the station to secure, until late in the season, additional pure-blood stock and by the typhoon of July 6, 1918, which, besides causing damage to buildings and equipment, killed most of the chicks and growing stock and a few of the older grade hens on hand at the time.

A small shipment of Rhode Island Reds was received from the States on February 5. Prior to this time the season's breeding work was confined mainly to the production of experimental and sales-breeding stock by mating native stock with selected Rhode Island Red grade cockerels and pullets. Along with breeding investigations an effort was made during the remainder of the season to produce as much unrelated pure-blood stock as possible by various matings of the imported fowls.

As the initial step in the work of developing the new breed previously referred to, 88 native hens and a number of cocks of white meat and plumage were secured. The native foundation stock for the first cross will be raised from these. In each process or step involved in the work of establishing this breed it is intended to use only selected fowls whose merit has been ascertained by individual pedigree records. Size, conformation, egg production, hatchability of eggs, and size and vigor of chicks will be the chief characteristics taken into consideration.

Feeding tests.—The feeding experiments were confined to tests with chicks from 1 to 12 weeks of age, comparison being made of the results of feeding various amounts of hand-squeezed fresh grated coconut as a supplementary ration.

Fresh coconut is perhaps the most common chicken feed used by the Chamorro rancher. It is a common practice to extract a portion of the oil from the product before making use of the latter as a feed. In this process water is added to the grated coconut meat and the juice squeezed out by pressure of the hands. This process is repeated until the juice has lost its milky white color. The liquid so extracted is boiled and the oil thus obtained used for household purposes, while the expressed pulp (hand-squeezed coconut) is used as a feed for live stock.

Hand-squeezed coconut as part ration for chicks from 1 to 6 weeks of age.—This experiment consisted of a series of four tests in which a standard mixed grain ration was supplemented by 20, 30, 50 and 75 per cent by weight of hand-squeezed coconut. The check ration in each case consisted entirely of the standard grain mixture which was composed of the following: Wheat 15 parts, corn 15 parts, oats 10 parts, cowpeas 3 parts (all finely ground), grit 5 parts, and charcoal 2 parts, the proportions being calculated by weight. The test and check lot in each series was given equal amounts of feed and otherwise received similar treatment. A total number of 794 chicks 1 week of age was fed at the time of the beginning of the tests.

The chicks receiving 20 per cent of coconut in the ration made the best total average gain of any of the lots. In this case the gain over the chicks in the check lot, or those receiving the straight grain ration, was made from the third to the sixth week. Up to the third week the chicks of the check lot made slightly the better gains. The feeding of the coconut did not result in an increased mortality over the check groups. This was true even when the maximum of 75 per cent of coconut was fed. A number of deaths was caused by cannibalism, a vice which was prevalent among some of the chicks under 2 weeks of age, and was more prevalent in the check than in the coconut-fed lots. Although the feeding of the larger amounts of coconut did not cause the death of chicks, many cases of what seemed to be paralysis appeared in the lots receiving over 30 per cent of coconut in the ration. Some of the chicks recovered and a few regained their normal rate of growth. The ailment was more common among the chicks under 3 weeks of age, except among those receiving 75 per cent of coconut, in which lot cases occurred up to the close of the test. The lots receiving above 30 per cent of the coconut also appeared droopy and otherwise off condition.

The total results of these tests indicate that an amount of squeezed coconut up to 30 per cent by weight of the total ration may be

advantageously fed in combination with certain grain mixtures to chicks, especially those above 3 weeks of age.

Local rations for growing chickens from 6 to 12 weeks of age.—In an experiment which included two tests, the value for young stock 6 to 12 weeks of age of native mixed rations (with the exception of meat scrap) in which coconut is an ingredient, was compared with the value of certain standard mixtures made up of imported grains.

Test No. 1: In this test each lot at the beginning consisted of fifty-eight 6-week-old chicks. The native mixed ration consisted by weight of 5 parts cracked corn, 5 parts cracked rice, 5 parts cracked cowpeas, 10 parts hand-squeezed, fresh-grated coconut, with the addition of 4 parts of meat scrap. The standard imported feeds consisted of a dry mash of corn meal 2 parts, wheat bran 2 parts, and meat scrap 1 part, and a scratch ration made up of cracked corn 2 parts, wheat 1 part, and coarse ground oats 1 part, the proportions in both cases being computed by weight.

The native ration was fed three times daily to the one lot while the chicks of the other lot received the standard scratch feed three times daily, the mash being kept before them at all times in self-feeders.

The chicks receiving the rations made up of imported grains made an average gain per chick of 1.05 ounces over those which were fed the native ration.

Test No. 2: In this test each of the two lots at the outset consisted of one hundred and seventy-two 6-week-old chicks. The ration of one lot consisted of equal parts by weight of cracked corn and hand-squeezed, grated coconut, fed three times daily as a scratch feed, with a supply of meat scrap accessible at all times. The opposite lot received the same standard scratch and mash rations that were fed in test No. 1. In this test the chicks fed the standard feeds made an average gain per chick of 1.13 ounces more than that made by each chick in the lot receiving the native ration.

REPORT OF THE AGRONOMIST AND HORTICULTURIST.

By GLEN BRIGGS.

AGRONOMY.

In general the agronomic work of the year was very disappointing. The typhoon of July 6, which destroyed nearly all the growing crops on the island, was followed by excessive rains for three months; transportation facilities were so poor that it was impossible at times to secure new seed material for planting, and an extended drought occurred during the last half of the year. However, advantage was taken of the situation to reorganize the work to a certain extent and to lay out more regular plats on the newly acquired tract joining the

station, while some of the field experiments were systematized and standardized. At the close of the year the work, with the exception of those experiments of long standing which were entirely destroyed by the typhoon, was well in hand again and in much better condition than it had been in former years.

Several meetings and conferences regarding agricultural matters of the island were held with the governor and committees during the year, with a view to changing some of the existing laws, providing a means of securing seed and tools and supplying other needs of the farmer, as well as of serving to increase food production. A number of trips were made around the island in the interests of the station and the Guam Industrial Fair.

The principal work of the year consisted of tests with forage crops, legumes, corn, and soils, and efforts to promote the more general use of improved implements. The work with legumes, both at the station and in cooperation with the native farmers, was very satisfactory. Other work of lesser importance was carried on with rice, tobacco, and cotton.

During the year two executive general orders affecting the agriculture of the island were promulgated by the naval government of Guam. The first of these reads as follows:

EXECUTIVE GENERAL }
ORDER NO. 289. }

GOVERNMENT HOUSE, GUAM,
August 23, 1918.

1. The prevalence of the war, the missing of the monthly transports in the past, and the possibility of similar missings in the future, all point to the necessity of increasing the agricultural and animal food products of the island. This is necessary, in the first place for pure self-preservation, in the second place to relieve the Federal Government of any obligation of supplying food to Guam of a kind that can be grown on the island and which is needed elsewhere.

2. It is therefore ordered and decreed that from the date of this order every able-bodied male inhabitant of the island between the ages of sixteen (16) and sixty (60) years, not otherwise fully engaged in some useful occupation, shall give his whole time, or his whole unoccupied time, to agriculture or the raising of cattle, food animals, or poultry. This time shall be put in on his own land, or under employment to others, or on idle land under Government or private ownership for a nominal rental.

3. The execution of this law shall be in the hands of the local commissioners and deputy commissioners, the duly authorized police authorities in the various districts, and the insular patrol, under such rules for registration and enforcement as shall be drawn by them and approved by the governor. The work of food production prescribed by this order shall, however, begin at once.

4. The penalties for violation of this order shall be the same as for violations of the vagrancy law, Executive General Order No. 136.

5. In the month of June next, 1919, an appraisal shall be made of all land under cultivation (other than to coconuts), and a bounty shall be paid to each owner or occupant of such land at the rate of fifty cents (50¢) per hectare.

ROY C. SMITH,
Governor of Guam.

Under the above order the farmers of each district were formed into groups of 5 to 10 men, one of whom was appointed leader. All

groups of a district were under the direct supervision of the patrolman of that district, the workers planting and cultivating their crops according to his direction. Each group worked on the farms of the members of that respective group, going from farm to farm in rotation. This method of farming was satisfactory as an emergency food production measure, but proved unsatisfactory as a permanent system.

The above order was succeeded near the close of the fiscal year by a second, which reads as follows:

EXECUTIVE GENERAL} ORDER No. 316. }

GOVERNMENT HOUSE, GUAM,
June 25, 1919.

1. Executive General Order No. 289 is hereby modified, to take effect on and after July 1, 1919. The following rules will be observed:

Every able-bodied male inhabitant of Guam over 16 years of age and under 60 years of age whose occupation is farming or who has no regular work will be required to cultivate at least one hectare of land. People who own no land must work for those who have land or must lease or purchase land.

Each family of three persons able to work all or a greater part of the time will cultivate at least the following crops or their equivalent if the land is better suited for other crops, namely: One-half hectare of corn; one-fourth hectare of garden crops, which must include beans or peas; 1,500 hills of sweet potatoes; 1,000 taro plants; 100 banana plants; 30 coconut trees; 50 pineapple plants. The sweet potatoes and taro plants should be planted in not less than three plantings so spaced as to insure a supply of food throughout the year.

The following are proper distances in feet between rows and between plants in rows, but modification is allowable due to location, nature of soil, etc.

Crop.	Distance between rows.	Distance between plants in rows.	Crop.	Distance between rows.	Distance between plants in rows.
	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Taro.....	1½	1½	Orange.....	15	15
Sweet potato.....	3	2½	Lemon.....	15	15
Corn.....	3	3	Grapefruit.....	15	15
Pineapple.....	4	3	Alligator pear.....	20	20
Banana.....	8	8	Coconut.....	30	30
Papaya.....	8	8	Mango.....	50	50
Coffee.....	8	8			

These distances should be increased rather than decreased.

For each additional person as above described able to work will be added at least one-third ($\frac{1}{3}$) of the above.

Each family will also plant the following trees in localities where they will grow until they have at least the following number growing: 3 alligator pear trees, 3 mango trees, 3 grapefruit trees, 5 lemon trees, 5 orange trees, 10 papaya trees (large variety), 25 coffee trees; one year will be allowed for putting this paragraph in effect.

Each family will be required to have at least the following stock and fowl: One bull, carabao, or other work animal; one cow; two sows; 15 hens; 3 roosters. A few turkeys, guinea fowls, or ducks should be raised in addition. (Water to swim in is not necessary for raising ducks.)

The compulsory working in groups is abolished, but all persons are urged to engage in friendly exchange of labor.

An inspector of crops, who will confer with the agricultural experiment station, will be appointed. His duties will be to see that all orders issued relative to crops are carried out. He will report to the commissioner or chief of police all delinquent persons.

In case of dispute relative to crops, the inspector of crops with the agricultural experiment extension agent and a person named by the farmer will decide the question. The inspector of crops will ascertain from the farmers the farming implements which the farmers desire to purchase through the island government, including seed containers as well as the amount of seed, fertilizers, insect destroyers, etc., which are needed in each district, and which the farmers of the district desire to purchase through the island government. This information will be needed to ascertain the number and size of seed containers needed for each district, and amount of seed and other things to order.

The commissioner of each district will furnish to the governor a list of the farmers who farm their lands; a list of the land owners who do not farm their lands; a list of men living in his district who do not own land; and those who have leased land for farming purposes.

The penalty for failure to comply with this order will be, for the first offense, executive fines not to exceed five (\$5) dollars, to be imposed by the commissioners of the various districts. Subsequent offenses may be punished by executive fines not to exceed ten (\$10) dollars. More than two offenses will render the delinquent subject to the vagrancy law.

All laws and parts of laws inconsistent with the provisions of this order are hereby repealed.

W. W. GILMER,
Governor of Guam.

FORAGE-CROP INVESTIGATIONS.

GRASSES.

Para grass (Panicum barbinode).—As has been the case in former years, Para grass furnished nearly all the soiling roughage fed to live stock during the year. It was one of the few feeds on the station grounds that was not killed by the typhoon of July 6. During the year land was prepared at the Piti station to receive additional plantings of this grass for pasture purposes. In February two hog runs were planted, and at the end of the year a good stand and a heavy growth of grass had been secured, which was being used as a pasture experiment. This stand had been obtained during one of the driest seasons experienced at this station, but it was necessary to irrigate rather frequently until the grass had become well established.

The work on the fertilizer test plats was discontinued during February because of the scarcity of other pasture grasses and the plowing up of some of the plats needing renovation. Half of the plats were plowed and planted to cowpeas, both the Para and cowpeas being allowed to grow. During the dry season, when other forage was scarce, these plats were pastured and furnished a large amount of feed for the station cattle. The ability of this grass to furnish feed at a time when it is most needed makes it highly superior to native forage plants.

The fertilizer, plowing, and manuring tests, which have been reported in former publications of this station, were continued until February to determine the residual effects of these treatments. The experiment was closed over a year and a half after the fertilizers had been applied to the plats and over two years after manure had been

applied and the plats plowed. The following table gives a summary of the yields from July to February:

Residual effect of various treatments to Para plats.¹

Plat No.	Area of plats.	Treatment.	Number of cuttings.	Acre yield of green forage.
	<i>Acre.</i>			<i>Tons.</i>
1	0.41	Commercial fertilizers.....	9	16.26
2	.41	No treatment.....	7	9.16
3	.23	Commercial fertilizers; plowed.....	5	12.44
4	.23	Plowed.....	5	7.67
5	.24	Commercial fertilizers.....	5	6.96
6	.24	No treatment.....	5	10.57
7	.21	Manure; plowed.....	6	6.44
8	.21	Manure.....	10	30.65

¹ For more complete details, see Guam Sta. Rpt. 1917, p. 17.

From these data it will be seen that barnyard manure alone gave the most lasting results and that plat No. 1, to which a large amount of commercial fertilizers had been applied, gave the second best yield during the seven months the test was conducted this year.

During the year tests were conducted with leguminous crops planted in Para grass fields (Pl. IV, fig. 1). Both cowpeas and velvet beans were used with very gratifying results. In the plats where two crops of velvet beans were planted, one succeeding the other, the yield of green forage was as follows: 1,298 and 3,220 pounds, respectively; and for the check plate, 760 and 805 pounds, respectively. Not only was the yield of forage greatly increased, but the feeding value was also improved by the addition of the nitrogenous bean vines.

Paspalum dilatatum.—The last seven months of the past fiscal year were the driest in the history of this station, but the *Paspalum* grass continued to furnish grazing during the whole drought. Even on the hillsides and the uplands some growth was made at all times, and where pastured the grass made more growth than where it was not pastured. This grass successfully withstood the typhoon and heavy rains which followed, and then the extreme drought, and remained in much better shape than any other grass or forage crop on the island. During the rainy season, *Paspalum* grass produced a great amount of seed. Germination tests of this seed showed an estimated 25 per cent of viable seeds. From the results with refuse *Paspalum* at Cotot, it was observed that the seed stems started new growth and roots at the nodes when spread on the ground. Cuttings of seed stems were planted in boxes, one-third of the cuttings being left protruding above the surface of the ground. In each case the cuttings produced a good growth, fully demonstrating the fact that *Paspalum* can be propagated from the seed stems as well as from seed and by root division. At the close of the year new clearings, amounting to about 8 acres at the Piti station and 20 acres at Cotot, were made for planting to *Paspalum*.



FIG. 1.—FIELD OF PARA GRASS IN WHICH VELVET BEANS ARE GROWING.



FIG. 2.—TEST PLATS OF COWPEAS DURING DRY SEASON.



FIG. 2.—BROOM CORN AND SWEET SORGHUMS. LEFT TO RIGHT—EARLY AMBER, HONEY, BROOM CORN, RED AMBER, ORANGE.



FIG. 1.—GRAIN SORGHUMS. LEFT TO RIGHT—WHITE KAFIR, DAWN KAFIR, EARLY KAFIR, BLACKHULL KAFIR, BROWN DURRA, FETERITA, SUNRISE KAFIR, SCHROCK KAFIR, YELLOW MILO, WHITE MILO, KAOLIANG, DARSO, DWARF KAFIR.

Guinea grass (*Panicum maximum*).—The station has only a small area of this grass but it has seemed to hold its own with other grasses that are growing around it. No care has been given the grass since it was planted several years ago. It has been cut frequently, as it is situated at one end of the lawn. However, as Para and Paspalum grasses have proved to be better adapted to Guam conditions, little has been done with guinea grass.

Sudan grass (*Andropogon sorghum*).—The ratoon crops of Sudan mentioned in last year's report were cut short by the effects of the typhoon. The sixth cutting of this grass planted January 6, 1917, was made on October 4, 1918, and yielded 2.1 tons per acre. The stubble was plowed up as the stand had been ruined. The planting of Sudan grass across the river made January 23, 1918, was also badly damaged. It was cut the second time on October 4, and gave a yield of 5 tons per acre without having been cultivated since the first cutting was made. Several plantings were made during the year but the seed failed to germinate. Work will be continued next year to determine further the value of this grass as a forage crop in Guam.

Bermuda grass (*Cynodon dactylon*), locally known as grama grass.—This grass is one of the best, if not the best, lawn grass on the island. It grows readily during the wet season and remains green throughout the dry season unless the drought is unusually severe. It is readily propagated by roots. In planting, furrows are laid out 3 feet apart, pieces of roots being dropped into the furrows at intervals of 2 or 3 feet and then covered. The plant takes root very quickly in moist land and soon covers the space between the furrows. In Guam, Bermuda grass is sometimes encroached upon by creeping stemmed native grasses, in which case fields or plats may be renovated by plowing. If the other grasses are removed with a sharp-pointed knife at frequent intervals, the stand can be kept in good condition.

During the year a part of the lawn in front of the office was plowed and planted to Bermuda grass roots. One-third of the area was given an application of nitrate of soda at the rate of 200 pounds per acre; one-third with lime at the rate of 1,000 pounds per acre; and the remainder was left to serve as a check. The plat treated with the nitrate made a slightly better growth and was a much darker green in color. No difference could be noticed in the check plat and that given an application of lime, although on and near the cascajo (which contains a large percentage of lime) paths the Bermuda does much better than elsewhere and other grasses do not crowd it out.

Guatemala grass (*Tripsacum laxum*).—The latter part of April, 12 canes and 1 root of this grass were received from the Office of Forage-Crop Investigations, United States Department of Agriculture. Only the root survived the long trip via San Francisco, Vladivostok, and Manila, but at the close of the year it had been divided, and two

plants each 2 feet high were growing vigorously. It is a perennial grass, resembling in a general way teosinte, and is used as a forage plant. Its development in this tropical climate will be watched with interest.

SORGHUMS.

The work with sorghums during the year was rather disappointing, as most of the station seed was lost in the typhoon and that which had been received from other sources either failed to germinate or developed a very poor stand. In the kafir and sorghum ratoon tests mentioned in last year's report, one cutting only was made after the typhoon. These two crops had been planted January 27, 1917, and the sixth and last cutting was made October 28, 1918. The kafir yielded at the rate of 2,292 pounds of forage, and the sorghum 4,224 pounds per acre. The typhoon badly damaged the crop, and the extremely wet weather following the storm made it necessary to discontinue the test and plow the field.

On December 6, 1918, a grain sorghum variety test was started. The following varieties were included in the test: Blackhull White kafir, White kafir, Early kafir, Dwarf hegari kafir, Dawn kafir, Sunrise kafir, feterita, shallu, white milo, yellow milo, brown durra, Darso, Schrock kafir, brown kaoliang, white kaoliang, Manchu kaoliang, and standard broom corn. Seed was secured from the Oklahoma and California experiment stations and the Bureau of Plant Industry, United States Department of Agriculture, but the poor stand obtained therefrom necessitated replanting several times. The last replanting made in February with new seed failed to germinate on account of lack of moisture. Those plants which grew did remarkably well, considering the fact that they had been planted and matured during a period in which less than 4 inches of rain fell.

Feterita and yellow milo proved to be the earliest varieties in the test. Dawn and the ordinary Blackhull kafir were the most promising of the kafirs. No yields were taken as the stand was very uneven. Seed was saved for future plantings. In another test, the Dawn kafir, which is apparently an early dwarf selection of the Blackhull kafir, gave a very good yield of both seed and forage and proved to be superior to the other varieties in the same test. Plate V, figure 1, shows some of the heads and stalks of the grain sorghums.

During June, two variety tests of grain sorghums were made under widely varied soil conditions. A good stand was secured with nearly every variety. These will be grown, not with the expectation of securing a good yield of grain during the rainy season, but to secure seed from successive crops for planting during the next dry season. It has been found rather difficult and uncertain to hold seeds over from one dry season to the next for planting.

A small variety test with sweet sorghum, started at the same time as the above grain sorghum tests, gave similar results. The varieties consisted of Honey, Early Amber, Red Amber, and Orange sorghums. The last-named variety gave the best results on both the old and new soils, but a better stand was secured in both cases. Near the close of the year two more plantings were made for new tests. Plate V, figure 2, shows the stalk and head characteristics of the four sweet sorghums and broom corn.

LEGUMES.

Special emphasis was placed upon the growing of legumes during the past year, with very satisfactory results, and some of the varieties tested by the station are fast finding a wide use as local feeds, both in grain and forage rations. Variety tests with seven different legumes were made on various soil types. The tests included Canada field peas; mungo, soy, jack, and velvet beans; and several varieties of cowpeas. Soy beans and Canada field peas were a failure in all tests. The mungos produced a fair crop of beans and matured in less time than any of the other varieties. During the extremely dry season the jack beans and velvet beans grew very slowly, but made vigorous growth during the wet season. The cowpeas did well in all cases and on all types of soil.

Cowpeas (Vigna sinensis).—The work with cowpeas during the year was highly satisfactory in all cases. This crop has been one of the most important forage crops grown at the station, especially during the dry season when it furnished large amounts of seed and green forage, and other crops were scarce or suffering from the extended drought.

The Chamorro farmer is rapidly taking to the cowpea, and its distribution and planting has probably been greater than that of any other new crop ever advocated by the station. Its use, however, has been limited to food purposes either for human, or, to less extent, for live stock, consumption; but a good start has been made and it is expected the plantings will continue to increase and that in the future the crop will be used more or less for green manure purposes. As cowpea seed on the island has all come from station distribution, it has been limited to the Whippoorwill variety, and the seed has been kept pure. The distribution will be confined to the same variety unless some of the other varieties under test prove to be better adapted to local conditions. All the legumes grown at the station, except those in the variety test, were used during the dry weather for forage purposes to supplement the pasture and other forage crops. They were relished at all times by all classes of live stock. Yields of 6 tons per acre of green forage from a single cutting were not uncommon during the time of extreme drought.

Several tests of the following varieties of cowpeas were conducted during the year: New Era, Whippoorwill, Early Buff, Iron, Large Blackeye, and Brabham, to which was added the Groit near the close of the year. (Pl. IV, fig. 2.) During the drought, all of these varieties made a good vine growth, but produced little seed at the height of the drought. Early Buff and Large Blackeye were found to be the earliest varieties, but were shy yielders of vine and peas. Iron and Brabham were vigorous growers and offer much promise as a cover crop, but the New Era and Whippoorwill, which were intermediate in growth, seemed to be well adapted for all purposes, and produced good crops of seed.

In one planting that was made in July, a yield of about 7 bushels of dry peas was secured from an area slightly over one-half acre in extent. Much seed was lost in this test during the Spanish influenza epidemic because of lack of labor for picking. Heavy rains which followed resulted in more loss of ripe seed.

In a forage test started January 8, in which Whippoorwill and New Era seed were planted broadcast and in drills 3 feet apart, the drilled plats gave the larger yield of peas, but the broadcasted areas gave slightly the more forage. The New Era variety blossomed earlier and set on a great many pods, while the yield of Whippoorwill peas, which are a later maturing variety, was affected by the dry weather to a marked extent. The following table shows the results of the test:

Comparative yields of two varieties of cowpeas planted broadcast and in drills 3 feet apart.

Variety.	Method of planting.			
	Broadcast.		Drill.	
	Yield of peas.	Yield of green forage.	Yield of peas.	Yield of green forage.
	Bushel.	Tons.	Bushels.	Tons.
New Era.....	0.75	6.80	16.99	4.88
Whippoorwill.....	.50	6.11	3.56	7.33

Of all the legumes, cowpeas made the best growth when planted in alternate rows with corn, kafir, and milo.

Velvet beans (*Stizolobium* spp.).—Two varieties of velvet beans, the Mauritius and Osceola, were tested during the year and gave fairly satisfactory results. The Osceola gave the largest seed yield and produced a heavy growth of vines. As has been mentioned under the heading grasses, the velvet beans when planted with Para grass gave a great increase in forage yields, due either to the added weight of the vines, the increased nitrogen supply stored in soil by the leguminous plant, or to both.

Near the end of the fiscal year a variety test was started, including the following varieties: Early Florida, Yokohama, White Hairless, Black Mauritius, Lyon, Alabama, Osceola, and Georgia, or One-Hundred Day Speckled.

Mungo bean (*Phaseolus aureus* or *P. mungo*).—This is a small bean grown in most tropical countries. It was originally the principal leguminous crop cultivated on the island, and the beans are greatly prized as a food by most of the Chamorro people. It grows readily on well-drained soil. The plant is of a bushy habit and fruits like the cowpeas, especially the variety known as Early Buff. The bean matures in from 60 to 90 days and the seeds ripen unevenly and shatter easily, making it necessary to pick them at frequent intervals. It did well at the station planted both in rows and broadcast. The broadcasted plats made a heavy growth and produced a large amount of pasture and green manure. Planting broadcast is especially adapted for cover crops or green manure where a crop is to occupy the ground for only a short time. The plats planted in drills yielded more peas than the broadcasted and grew more rapidly as a result of the cultivation they received.

Jack bean (*Canavalia ensiformis*).—The jack bean was the only legume at the station that withstood the heavy typhoon of last July, but the plants were badly twisted and broken, and were stripped of leaves. This is a hardy plant and makes a bushy upright growth. During the year the beans in the pods were badly attacked by an insect which injured at least 50 per cent of the crop. This is the only time this bean has suffered insect injury during the last three years.

Alfalfa (*Medicago sativa*).—As was mentioned in last year's report, the growing of alfalfa is very doubtful in this climate. All plats on the station succumbed during the heavy rains of last July and August. A large number of tests have been carried on at the station during the last four years under widely varying soil conditions and at different seasons of the year. In some cases as many as two good cuttings have been secured, but in all tests the plants died sooner or later, which proves conclusively that alfalfa can not be grown at the station because of unsuitable soil or climatic conditions and low altitude.

Sweet clover (*Melilotus alba*).—Several plantings of this legume have been made but with little success. During the year two plants survived from one test and produced an abundant supply of seed. This seed was planted in a small plat, and at the close of the year a good stand was growing in one of the fields.

ROOT CROPS.

A good start has been made with the native root crops in the hope of developing one or more forage crops which will fit into the local

feeding rations. Variety tests consisting of arrowroot (*Maranta arundinacea*), two kinds of cassava (*Manihot manihot* or *M. utilissima*) seven of sweet potatoes (*Ipomœa batatas*), and nine of taro (*Caladium colocasia* or *Colocasia esculenta*) were under way at the close of the year in addition to one of edible canna (*Canna edulis*), and one of chufas (*Cyperus esculentus*).

The taro was planted late and many of the plants died during the drought, while some others were eaten by crabs. The cassava, arrow-root, and sweet potatoes did well, and propagating material for larger field tests were secured for planting the next year. In a test with edible cannas planted March 7, 1918, and harvested during October, a yield at the rate of 5,525 pounds of tubers was secured. These were used for planting a larger field area, but made a very slow growth during the dry season. At the close of the year, after a few rains had supplied sufficient moisture, they were making a rapid growth.

DRYING AND STORING SEED AND FOOD PRODUCTS.

After the typhoon, and when food crops and seed were very scarce, the people were induced to plant large areas of sweet potatoes as a means of quickly providing a large amount of food on the island. This resulted in a great overproduction of sweet potatoes and the market was glutted. In an effort to help the people save this surplus food, the station immediately started experiments in drying to determine a suitable means of preserving the crop. This was necessary because of the presence on the island of sweet potato weevils (*Cylas formicarius* and *Euscepes* (*Cryptorhynchus*) *batatae*) which injure and greatly damage the mature potatoes if they are left in the ground for any length of time.

The drying investigations were all of a practical nature and were conducted with material that is found around every home. As the work progressed the storage problem became harder to solve than at first thought, and as a means of properly protecting the dried product was fully as important as a means of preserving food, the study of the storage problem was added to the other investigations. Some years ago, when it was found that seeds would not keep in the open in this climate, specially designed tanks were constructed, and these are still used by the station for seed-storage purposes. These tanks were also found to be satisfactory for storing the dried products as well as seed in large quantities. Seed in small quantities may be kept in bottles which can be properly stoppered by pushing the cork part way down the neck and putting a heavy oil on top of the cork to keep out weevils and moisture. Acting upon the advice of the experiment station, the island government is making tanks, modeled after those at the station which are insect, moisture, and rat proof,

and, as nearly as possible, capable of withstanding typhoons. These tanks are offered for sale to the farmers at manufacturing cost.

While the tests of means of preparing, drying, and storing sweet potatoes were under way, several other crops were also tested for preserving as stock food and for human consumption. This work was found to be very important, especially after the typhoon, when no food other than what had been stored was to be had on the island. In addition to white and yellow sweet potatoes, bananas, green beans, taro, edible canna, arrowroot, papaya, cassava, roselle, coconuts, and breadfruit were used in the test. Data have been prepared and it is planned to offer the results of the drying and storing of seed and food products for publication in the near future.

COTTON (*GOSSYPIMUM* SP.).

All cotton varieties growing in the station fields were killed by the typhoon of July 6, 1918. The seed which previously had been saved was stored in the barn but unfortunately, when removed from the sacks by the laborers, the seed was mixed and the labels were lost. This necessitated restarting all cotton work. Considerable difficulty was experienced in getting seed from the States, due to delays and lack of transportation. None of the Egyptian seed that was received germinated. On June 17, a variety test including the following short staple varieties was planted: Trice, Express, Wanamaker, Cleveland, Foster, Mebane Triumph, Lone Star, Columbia, and Cook. A cotton that has been growing on the island in a wild state and apparently is of Sea Island origin was also included in the test.

CORN (*ZEA MAYS*).

Fortunately corn in the ear-to-row breeding work, the most important experiment being carried on at this station, was sufficiently mature to permit the saving of some seed after the destructive typhoon which swept the island in July. This corn was the eighth generation of selected seed. Two days after the typhoon, it was harvested in a pouring rain and from a flooded field, the stalks having been blown flat and broken. While the seed has been limited, it has been husbanded with great care. Sixty-five rows of the 10th generation, which were planted on June 17, were doing well at the close of the year. Dwarfness of stalk, one ear to a stalk, and the habit of early maturing are characters which, having been selected in the 10 generations, seem to have become fairly fixed, but the yield apparently has decreased.

After the typhoon, selections were also made from the breeding plats for the number of rows of kernels to ear, long shuck for weevil protection, and the soft and flint strains of Guam corn. Though every possible care under the circumstances was given this seed,

and it apparently was well preserved, it proved to have no germinative powers. In February new plantings were made on ground that could be irrigated. These were harvested June 20 and selections again made with which to carry on the work.

Not only was seed saved from the most important experimental work after the typhoon, but the station superintended the picking, drying, shelling, and storage in moisture, weevil, and rat-proof tanks, of a quantity of seed corn sufficient for planting the island during the next season. This was a valuable service to the people, as only three fields of corn on the whole island were mature enough to furnish seed. Moreover, the native farmers had no means of saving or drying seed, as their buildings had all been blown down and heavy continuous rains lasted for some time after the storm. If the corn had not been commandeered by the naval government and taken care of by the station, this seed would have been largely lost as the result of the prevailing wet weather and the acute food situation. As soon as it became apparent that this would be the only available supply of seed for the next year's crop, good care was given the seed of the Guam corn in order to preserve it, since in numerous tests it has proved better adapted to local conditions than any variety that has been imported. It is considered that the saving and distribution of this seed was one of the most opportune as well as one of the most important things this station has done for the island as a whole, especially as it was done at a time when war conditions made transportation uncertain and seed and food scarce.

RICE (ORYZA SATIVA).

The work with rice this year was practically limited to fertilizer tests, time of planting, and insect control studies. The fertilizer tests were a continuation of the work of former years. The following table gives a summary of results secured from this experiment:

Effect of fertilizers on yield of rice.

Plat No.	Treatment per acre.	Total yield of unhulled rice.	Average rate per acre.	
			First grade rice.	Straw.
		Pounds.	Pounds.	Tons.
1	Check.....	1,520	725	5.19
2	Sodium nitrate, 266 pounds.....	1,120	622.5	6.90
3	Ammonium sulphate, 200 pounds.....	715	350	5.85
4	Acid phosphate, 166.5 pounds.....	1,905	1,355	6.91
5	Potassium sulphate, 95 pounds.....	1,420	747.5	6.46
6	Sodium nitrate, 266 pounds; acid phosphate, 166.5 pounds; potassium sulphate, 95 pounds.....	505	332.5	6.35
7	Ammonium sulphate, 200 pounds; acid phosphate, 166.5 pounds; potassium sulphate, 95 pounds.....	1,832.5	1,125	7.00
8	Ammonium sulphate, 200 pounds; potassium sulphate, 95 pounds.....	1,582.5	820	7.11
9	Acid phosphate, 166.5 pounds; potassium sulphate, 95 pounds.....	535	115	7.07
10	Ammonium sulphate, 200 pounds; acid phosphate, 166.5 pounds.....	2,895	2,070	4.95
11	Lime, 1,000 pounds.....	1,610	960	7.95
12	Ammonium sulphate, 200 pounds; acid phosphate, 166.5 pounds; potassium sulphate, 95 pounds; lime, 1,000 pounds..	642	310	7.03

The first column of the table shows the total yield of unhulled rice, the second gives only the best or first-grade unhulled rice after the light and shrunken kernels due to rice bug damage had been removed. Plats 3, 6, 9, and 12 were so badly infested with rice bugs and damaged to such an extent that they should not be compared with the other plats. Sixteen plats that were not fertilized made an average yield of 1,080 pounds of unhulled rice, or 625.5 pounds of first-grade undamaged rice, and 4.62 tons of straw to the acre. From these results it would appear that in general those plats which had received applications of phosphorus gave the highest yields of rice.

Four plantings were made in the station experimental test plats on the following dates: September 13, 1918, March 26, May 20, and June 18, 1919. Observations were taken on plantings made near the station by native farmers on September 1, October 1, and October 30, 1918. The plantings made since March grew slowly during the hot dry season and have not produced a crop up to the present time. Only those plantings made before October 1 produced anything like a crop, and the earliest plantings were the only ones that escaped serious damages by the rice bugs. Selections were made from an early strain of rice appearing in the experimental plats, and enough seed was secured to plant the station fields next year.

The rice bug (*Leptocorisa varicornis*), mentioned in last year's report, damaged the late-maturing rice so badly on the island that in several cases it was not harvested. It was very noticeable that the experimental plats near the clean cultivated fields were not damaged nearly so much as were those near grass and brush land. The bugs went from the rice fields into the grass during the middle of the day and returned to feed upon the rice in the evenings and early morning. Great quantities of bugs were caught in a cloth bag smeared with coal tar and carried rapidly across the field, but without appreciable success in diminishing the damage. Apparently rice fields surrounded by cultivated or fallow fields are less subject to attack than those near grass and brush, as is the case in nearly all the rice fields on the island. It would appear also, judging from the experience gained this year, that the early-maturing strains of rice may escape a large part of the heavy infestations occurring from later broods of the rice bugs.

The leaf folder did considerable damage, especially to the later plantings when they were in the young stage. By folding the leaves, the bugs cause the crop to make a slow and very distorted growth.

GREEN MANURE AND COVER CROPS.

Only leguminous crops have been used by the station for turning under or for cover crops. Few tests were completed during the year owing to the typhoon which early in July, 1918, destroyed all growing crops with the exception of the jack beans, and to the use of all the crops for forage purposes during the last half of the year when other crops were cut short by the drought. Various legumes have been planted in the orchards and vacant plats as well as in several pastures and in the field. Plantings were made of several varieties of cowpeas and of velvet beans, soy beans, jack beans, mungo beans, and Canada field peas. Cowpeas proved to be the best cover crop during the long, dry season, but velvet beans produced the best growth during the rainy season. Soy beans and Canada field peas were the poorest cover crops in the test as they produced little vine and occupied the ground for only a short period. Jack beans made a fairly efficient cover crop and were the only ones able to withstand the terrific force of the typhoon. Mungo beans made effective cover crops when planted close together in rows or when sowed broadcast, but lost their efficiency after reaching maturity, which is 60 to 90 days after planting.

Near the last of July the entire station garden area was planted to cowpeas. A good stand was secured during even the extremely wet season immediately following the typhoon. It was intended to plow these under for a green manure shortly after blossoming, but owing to the scarcity of all kinds of seeds upon the island and the uncertain transportation to Guam, they were left until they had matured considerable seed, after which the vines were disked and plowed under. Since that time a very noticeable change has occurred in the condition of the soil, which is not packed, run together, baked, nor cracked as is that soil of the same type which was not similarly treated. This same effect has also been observed in other types of soil on the station when green manures have been plowed under. In all cases they produce a more friable and improved physical condition in the soil.

TOBACCO.

Much interest has been manifested in the recent spraying experiments carried on by the station to combat tobacco insects. It is customary for the Chamorro farmer to pick the worms from the leaves by hand, a tedious and disagreeable practice. Tests were made during the year to compare the cost and effectiveness of hand worming and of spraying tobacco with lead arsenate. The field was arranged in four plats, each two-tenths of an acre in size. Two plats were planted to Orinoco and two to native varieties of tobacco. One plat in each variety was sprayed and one hand wormed.

The following table gives a summary of the yields from the different plats:

Summary of results of spraying and hand worming tobacco, 1919.

Plat No.	Variety.	Treatment.	Number of plants.	Weight of stalks.	Weight of leaves.	Number of leaves.	Number of first-grade leaves.
				<i>Pounds.</i>	<i>Pounds.</i>		
1	Orinoco.....	Sprayed.....	84	59	92.25	2,626	295
2	Native.....	do.....	82	58	67.25	2,858	177
3	Orinoco.....	Hand wormed....	71	51	62.00	2,196	127
4	Native.....	do.....	65	47	58.75	2,055	168

It will be noted that the sprayed plats yielded considerably more leaves, more first-grade leaves, and a greater amount of leaves than did the hand-wormed plats.

The cost of labor in hand worming was found to be \$5.34 per plat the labor cost of spraying was \$1.83 per plat, and the cost of spray materials was \$3.91 per plat. The difference in cost was found to be \$0.40 in favor of the hand worming. The yields in the sprayed plats more than made up this difference. However, the test will be repeated as it is thought that the spraying costs can be materially reduced.

Another interesting point brought out in the test was the higher yield made by the Orinoco variety over the native tobacco.

Comparison of yields of the two varieties.

Variety.	Weight of stalks.	Weight of leaves.	Number of leaves.	Number of first-grade leaves.
	<i>Pounds.</i>	<i>Pounds.</i>		
Orinoco.....	110	154.25	4,822	422
Native.....	105	126.00	4,913	345

SOILS.

Work on the soils was delayed during the early part of the year on account of the urgency of other projects and of the repair work necessitated by the typhoon. Pot and field tests were started in October in order that a study might be made of the difference in productivity of the different soils, especially the old and newly broken soils mentioned in last year's report. Samples of soils taken from the old plats on the station, from grassland broken in July, 1917, and from newly broken grass land (October, 1918) were used in pot experiments. Corn, kafir, cotton, cowpeas, radish, peppers, and rice were grown in the pot and field tests. Although scarcely any difference was observed in the chemical analyses of these soils, all of which received the same physical treatment after being removed

from the field, a great difference was noted in the yield of most of the crops grown upon them. Two crops were harvested from each soil. The old soil gave the largest yields, but the difference was much less in the second test than in the first as the new soils seemed to increase in productivity. However, in both crops very little difference could be noticed in the pots and plats which had been planted to rice and cowpeas. Native wild grasses, such as were growing on the newly broken grassland, were also planted in large pots containing the old soil in order that a study might be made of the effect this would have on crops planted on this soil at a later date.

On March 15, 1919, another test consisting of 156 pots in 26 series was started in an effort to determine the comparative need and value of commercial fertilizers and local fertilizer products on the old and newly broken grasslands of Guam. Corn was planted in all of these pots. The commercial fertilizers consisted of nitrate of soda, potassium sulphate, acid phosphate, lime, ammonium sulphate, and bone meal, either singly or in various combinations. The local products consisted of barnyard manure, lime, velvet beans as a green manure, cowpeas as a green manure, coconut husk ash, sea slugs, seaweeds, and bat guano. The first crop was harvested near the close of the year and showed some very interesting results. Certain of the local products gave equally as good results as some of the commercial fertilizers. Manure was very beneficial to both soils. Lime on the old soil and bat guano on the new soil helped produce a good growth of corn, while seaweeds, coconut husk ash, and certain combinations of commercial fertilizers containing acid phosphate were noticeable in their beneficial effects.

During the year some effort was made to find caves which might contain sufficient deposits of bat guano to furnish supplies of fertilizer to the farmers of the island. However, time was so limited that it was impossible to do any of this work except outside of office hours and on holidays. Only one cave containing a deposit of any size was found. This deposit was in the neighborhood of Dededo. No doubt more deposits exist on the island and could be located by a more extensive search, as bats are known to exist in large numbers near some of the bluffs on the island.

The following analysis of the guano was furnished by the Bureau of Soils, United States Department of Agriculture: Total nitrogen (N), 6.78 per cent; total phosphoric acid (P_2O_5), 6.31 per cent; potash (K_2O), 0.38 per cent. This shows the guano to be rich in nitrogen and phosphoric acid, the two elements most needed by Guam soils.

A suitable local fertilizer which would be within the reach of the farmer is greatly desired. It is out of the question to expect the Chamorro farmer to do much with commercial fertilizers when

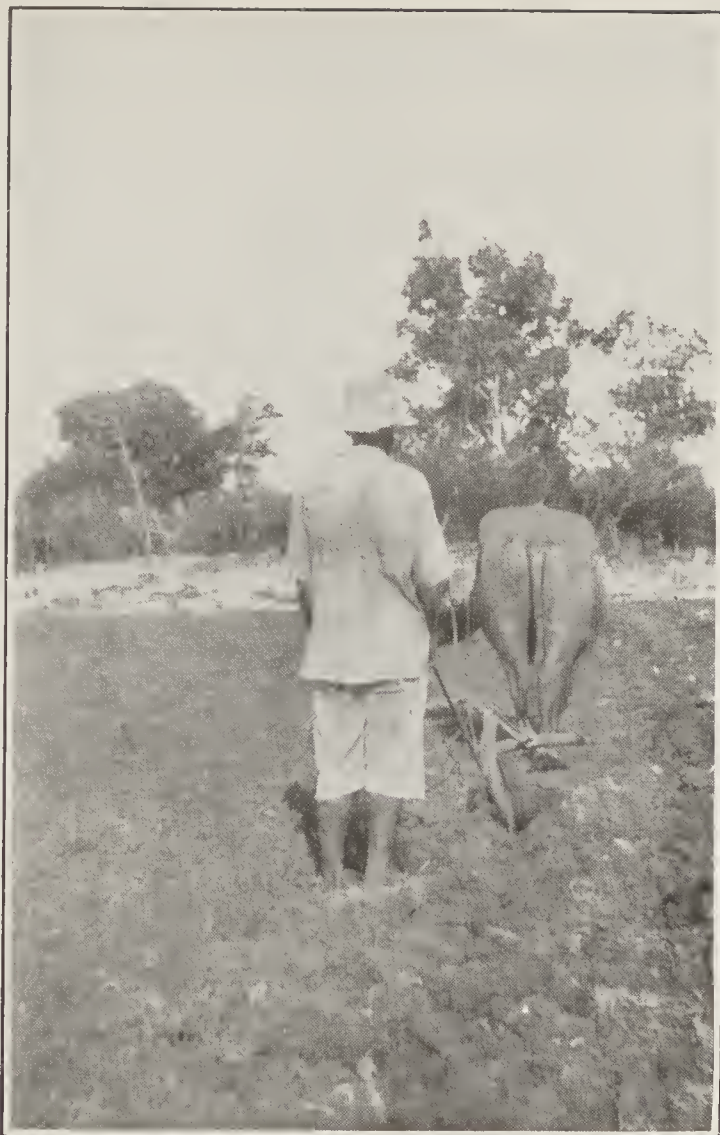


FIG. 1.—SMALL ONE-HANDLED PLOW USED FOR PLOWING AND MAKING FURROWS FOR PLANTING.



FIG. 2.—A CULTIVATOR USED TO KEEP DOWN WEEDS.

TYPES OF FARM IMPLEMENTS GRADUALLY BEING ADOPTED BY GUAM FARMERS.



FIG. 1.—SPIKE-TOOTH HARROW.



FIG. 2.—DISK HARROW CUTTING VELVET BEANS.



FIG. 3.—VARIETIES OF TOMATOES.

transportation facilities are so poor and freight rates so high. If guano deposits in sufficient quantities could be found they would at least partly solve the problem of supplying cheap fertilizer to the farmer and allow him to increase his yields of garden and other food products that are grown on small areas in a rather intensive manner.

IMPROVED FARMING METHODS.

The trend of the Chamorro farmers toward the employment of more improved farming methods as an outcome of a more extensive use of animals in farming their land should be mentioned in connection with the growing of crops. Ever since this station has been established, the use of more improved types of tools and implements has been advocated and demonstrated. However, it is only recently that much progress has been noticed in this direction with the exception of the few progressive farmers who live near the experiment station. Plate VI, figure 1, shows a plow being used for opening furrows preparatory to planting corn and grass. Plate VI, figure 2, shows a cultivator being used in a cornfield.

During the last three years efforts have been redoubled to get the farmers to use a bull, or carabao, and a plow and cultivator in tilling the soil. While the implements now used would not by any means be considered as modern in the light of farming methods on the mainland, nevertheless, they are adapted to local conditions and within the means of the farmers of the island. The implements most needed by the farmers are a small one-handled steel plow; a one-horse 5-shoveled, expanding lever cultivator having wheel attached in front; and a leveling harrow. Other implements in common use on the station where they have attracted considerable attention are a mower, disk harrow, and a pulverizer. Plate VII, figure 1, shows a one-section spike-tooth harrow used in leveling plowed ground.

These improved implements are becoming more in demand and frequent inquiries are made about them at the station. It seems that the farmers are realizing more than ever the advantage of using animal-drawn implements and are adopting them to considerable extent. In some districts the farmers have made complete harrows from hardwood, or have purchased material for teeth and made the frames. During the last season plows were used in preparing land to a greater extent than ever before and the demand exceeded the supply. Only lack of transportation kept many more plows from being purchased on the island. Arrangements have been made by which the Naval Government of Guam has purchased a number of plows, cultivators, and other needed tools which are to be sold to farmers. Plate VII, figure 2, shows a disk harrow being drawn by

two carabao and cutting up a cover crop so it can be turned under for green manure.

HORTICULTURE.

The horticultural work of the year was largely of a reconstructive nature. The typhoon practically destroyed or badly damaged everything. Replantings have been made in most of the tests, but wherever possible fruit trees were saved by pruning, budding, or grafting. Fruit of nearly all kinds was produced in very limited quantities throughout the year. However, toward the last of the year papayas, bananas, and pineapples were beginning to mature some fruits, and a few avocados and mangoes of inferior quality were produced. The only new work started was the establishment of a small citrus orchard consisting of native limes, lemons, oranges, and tangerines or mandarins. During the dry season, considerable budding and inarching of mangoes was done.

It was necessary to change many of the plans for the continuance of the work. The plant and propagating houses were completely destroyed by the typhoon, but have been temporarily rebuilt. Instead of replacing the roof of the shade house with iron roofing it was converted into a slat house for potted plants and flats needing only partial shade.

Special emphasis was given to seed and plant distribution, tomato growing, coconuts, and food production activities, insofar as possible while endeavoring to reconstruct and reorganize the experimental work along horticultural lines.

TROPICAL FRUIT INVESTIGATIONS.

This work has progressed very slowly due to a large number of the plants and trees being badly damaged, uprooted, or killed by the typhoon. A large number of the fruit trees were replanted and given a severe pruning in an effort to save as many as possible. Suckers and new growth have been very much in evidence on all the trees since the typhoon and have necessitated frequent pruning and a large amount of care.

The citrus trees, especially the smaller ones, apparently were not injured so much as most of the other fruits, but all that were not killed suffered some damage. At the close of the year, those that were alive had recovered and were making a slow growth. The difference in the growth between those trees that were properly cared for and those receiving no attention was very noticeable. The trees that were straightened, replanted, braced, and pruned, were greatly superior to those that received no attention after the storm. It will be some time before fruit production in the island will recover from the effect of the typhoon.

A small citrus orchard, consisting of oranges, lemons, limes, and tangerines or mandarins, was established during the year. The seedlings were grown from selected seed taken from trees bearing exceptionally good fruit.

Some of the imported citrus trees are showing signs of the bark disease similar to that on many of the native trees of the island. This disease has not been identified, and of the several remedies tried none has been effective for holding it in check.

The papaya experiment, conducted for the purpose of comparing the effects of barnyard and chicken manures, was destroyed by the typhoon, but has been restarted.

The rose apple (*Eugenia jambosa*), which was introduced from the Philippines November 1, 1910, produced a good crop of fruit during the year. This was the second crop, the first being a light one last year.

The following fruit trees and plants are growing at the station and are under investigation to a more or less extent: Limes (*Citrus medica acida*), lemons (*C. medica limon*), oranges (*Citrus* spp.), grapefruit (*C. decumana*), papayas (*Carica papaya*), mangoes (*Mangifera indica*), grapes (*Vitis* spp.), bananas (*Musa* spp.), rose apples (*Eugenia jambosa*), pineapples (*Ananas sativa*), star apple (*Chrysophyllum cainito*), tangerines (*Citrus nobilis*), avocado (*Persea gratissima*), litchi (*Nephelium litchi*), chico (*Achras sapota*), aneroa (*Aberia gardneri*), jujube (*Zizyphus jujuba*), mabolo (*Diospyros discolor*), santol (*Sandoricum koetjape*), bilimbines (*Averrhoa carambola*), kumquat (*Citrus japonica*), passiflora (*Passiflora quadrangulis* and *P. grandiflora*), pomegranate (*Punica granatum*), sapote (*Diospyros kaki*), roselle (*Hibiscus sabdariffa*) and *Carissa arduina*.

The station continued cooperation with Mrs. Glen Briggs in the study of methods of preparing and using tropical fruits, whenever they were obtainable, and in a similar study of some of the tropical vegetables grown at the station. The results were very gratifying and will become more valuable as the production of fruits and vegetables increases. The station receives and files copies of all recipes with the other records.

GARDEN VEGETABLE DEMONSTRATIONS.

The garden work was carried on under difficulties during the greater part of the year. Much of the work has given negative results, as a large number of the plantings have been failures. The typhoon was followed by heavy continuous rains, these in turn by a six months' drought, all of which made conditions very unfavorable for growing plants.

The regular time-of-planting experiments, which have been in progress for a number of years, were greatly interrupted by lack of a regular supply of seed and by weather conditions. During the third

quarter of the year work was again well started, but water in the regular supply system became so scarce that it was necessary to conserve it in every way possible, and after it was cut off from the garden the plants soon died.

The tomato work, which has received special attention during the last two years, was continued with very satisfactory results. The station has been working with two new varieties that give much promise of being readily adapted to tropical conditions, such as exist in Guam. One of these is the Cristobal variety, which was mentioned in last year's report, and which is being developed by the station. It has become larger, much smoother, and more improved in flavor during the five generations it has been selected. The selection work is carried on in regular garden plats, the most desirable plants and fruits in each generation being selected and the seed saved. Instead of limiting the distribution of the seed until the type becomes established, as is usually done with new varieties, the surplus seed is being distributed to as many farmers as possible in the hope that some seed might be saved in other places in case of misfortune to the seed or plants on the station. Tomato seed rapidly deteriorates and loses its viability in this climate, and it is considered best to have as many plants as possible growing all the year.

The other promising tomato is a Hawaiian hybrid introduced here near the first of the year. It grows luxuriantly and tends to spread on the ground. The vines are a light green color and rather large. This hybrid is a prolific bearer, producing medium-sized, smooth fruits of three distinct shapes, oblong, round, and a triangular pear shape. Seed of the three types were selected for planting and an effort is being made to segregate them and grow only the one that proves to be the best. The fruits of all these types have a very thick skin and the meat is not solid and contains but little acid.

Variety work has shown that only certain tomatoes give large yields and seem to be suited to the climate of Guam. Those plants, seed of which have been imported from the States, have been more or less failures. The following table gives the tabulated results of a variety test conducted during the year. The plats were three-hundredths of an acre in size, and all were given the same cultivation and treatment.

Results of variety tests with tomatoes.

Variety.	Num- ber of toma- toes per plat.	Weight of to- matoes per plat.	Average weight of each tomato.	Variety.	Num- ber of toma- toes per plat.	Weight of to- matoes per plat.	Average weight of each tomato.
		<i>Pounds.</i>	<i>Ounces.</i>			<i>Pounds.</i>	<i>Ounces.</i>
Stone.....	329	43.75	2.12	Native Ubas.....		230.00	.....
Ponderosa.....	143	50.68	5.67	Cristobal F ₄	4,911	607.62	1.97
Dwarf Champion.....	578	97.43	2.58	Hawaiian hybrid F ₂	6,200	635.93	1.64

It will be noted that the least prolific of the varieties produced the largest tomatoes but that the yield was not large enough to be profitable. Tomatoes weighing almost a pound were obtained from the Ponderosa variety, which, however, yielded only one or two fruits to a plant. The Native Ubas was the most prolific of all the varieties, but is very small and of high acidity. Plate VII, figure 3, shows the relative size of the different varieties.

SEED AND PLANT DISTRIBUTION.

Seed has been scarce on the island since the typhoon. Inasmuch as most of the people have had to depend upon the station for a new supply of seed since the typhoon, greater results probably have been secured from seed distribution. In order to meet the demand the station not only imported seed but grew large quantities of it, especially of various varieties of beans and cowpeas.

The distribution to farmers during the year was as follows: Six thousand six hundred and forty-nine packages of garden seed, 3,138 plants of various kinds, 7,045 pounds of seed corn, and a large amount of cowpeas and velvet beans besides small amounts of grain sorghum and other field-crop seed.

The nursery still contains a large number of economic plants that were expected to be very much in demand, such as oranges, lemons, mangoes, avocados, papayas, and coffee. However, because of lack of transportation and the food shortage which resulted from the typhoon, the farmers were urged to grow only quick-maturing food crops, and the ranchers had little opportunity of securing and planting fruit trees and plants. This probably largely accounts for the small demand for nursery stock at a time when the supply would naturally be expected to fall short of the demand.

COCONUTS.

Coconut experiments, both at Cotot and Tarague, have been continued with fertilizers and cover crops. No definite results can be expected for several years, but the plats at Cotot, which have been kept clear of grass, are making a better growth than the trees in those plats to which applications of fertilizers were made and where the grass was allowed to grow except just around the trees. The leaves of the trees in the plats treated with ammonium sulphate at Tarague have a much darker green color than have those of any other plat. No other difference can be noticed in the plats. During the dry season the cowpeas made a better growth and were more efficient as a cover crop than were the jack beans or velvet beans.

Plans were completed for more cooperative tests with coconuts at Tarague on the Atkins-Kroll plantation. These tests include a dynamiting experiment on soil underlain by a very hard cascajo

rock; a continuous tillage test, only one man and a plow handling as large an area as possible to keep down weeds all the year, and additional varieties of cover crops on a greatly increased area. The dynamite was on the ground at the end of the year and the plows and leguminous seeds had been ordered.

Arrangements are also under way in cooperation with the naval government for importing a cargo of well-selected seed coconuts from the Philippine Islands. The nuts will be brought to Guam and sold at actual cost without freight or other charges. Many plantation owners and farmers have already signified a desire to purchase the better seed nuts.

The following copra order was promulgated by the governor of Guam shortly after the close of the fiscal year:

EXECUTIVE GENERAL }
ORDER No. 319. }

GOVERNMENT HOUSE, GUAM,
July 14, 1919.

It has been found after experimenting that one hundred (100) pounds of meat of ripe coconuts will produce about sixty-five (65) pounds of first-class copra when properly dried, for which the producer should receive at least three (3¢) cents a pound, making the value one dollar and ninety-five (\$1.95) cents.

The same weight of coconut meat taken from unripe nuts will produce about fifty (50) pounds of poor quality of copra worth about two (2¢) cents a pound, making the value about one dollar (\$1) or about half the value of well dried copra made from ripe nuts. So much poor quality of copra has been produced in Guam that the copra made here has a poor reputation in the outside market.

The real gauge of the value of copra is its condition upon arrival at destination. Most of the copra from Guam goes to San Francisco and has to be in the hold of a schooner from fifty (50) to sixty (60) days. None but first-class copra can stand such a trip without undue deterioration.

The deterioration in copra is chiefly caused by containing too much water, due to not being properly dried, being made from unripe nuts, when the copra contains too much free fatty acid, or by getting wet during the curing. Any of these conditions cause rapid deterioration of copra when stored in bulk. Even a small amount of poor copra mixed with good copra will cause rapid deterioration in the whole cargo.

The shrinkage in Guam copra after purchase averages about fifteen (15) per cent. It should be in the neighborhood of five (5) per cent.

The exporters of copra will pay the producers at least three (3¢) cents a pound for first-class copra.

In order to improve the quality of copra and increase its price, the following regulations will go into effect immediately:

1. None but ripe nuts will be used.
2. All copra must be well dried before being presented for sale.
3. All copra must be cut in strip not more than one and one-half ($1\frac{1}{2}$) inches wide (one inch is better).
4. By January 1, 1920, all copra producers must have a drying shed suitable to their needs. Community sheds for small producers will be allowed. All copra must be dried on ventilated frames well clear of the ground and must be protected from rain.
5. A copra inspector will be appointed who will be directed to inspect copra wherever found and at any time.
6. On and after October 1, 1919, it will be unlawful for any producer to sell, or any purchaser to buy, any but first-class copra, which is defined as copra made in

accordance with the above regulations, except in case of a typhoon or other disaster when special orders will be issued.

7. The penalty for violation of this order will be a fine not to exceed one hundred dollars (\$100) or imprisonment not to exceed ninety (90) days or both.

8. All laws and parts of laws inconsistent with this order are hereby repealed.

W. W. GILMER,
Governor of Guam.

An experiment in making copra from coconuts in different stages of ripeness gave some very interesting results. Nuts in six stages of maturity, ranging from very green, immature nuts, to those that had sprouted and were growing a palm two or more feet tall, were used in the test. Different methods of making sun-dried copra were also tried during the above tests. It was found that the shrinkage at the end of five days' drying varied from 22.71 per cent to 69.21 per cent, and at the end of 11 days' time it varied from 26.26 per cent to 72.03 per cent according to the ripeness of the nut, the green nuts giving the greatest shrinkage and the growing ones the least.

It was found that the most copra was made from the nuts that had just sprouted, but that the fully matured and well-cured nuts that had fallen to the ground of their own accord gave the best grade of copra and were a close second in yield. The lowest grade copra was made from the immature half-ripe nuts.

Copra that was cut out of the shell when the nuts were first opened, as is the usual Chamorro practice, gave a better product than that allowed to remain in the half shell until it was loosened by shrinkage. The nuts dried on a bamboo frame raised from the ground about 2 feet, gave a slightly better quality of copra than those left on a mat upon the ground, due to the better circulation of air.

Examinations of mature husked nuts gave the following average percentages: Weight of shell, 22.77; weight of the water (sometimes incorrectly called the milk), 16.10; weight of the coconut meat, 58.16, which after drying and becoming copra was only 34.90.

An exhibit which attracted a great deal of attention was made at the third Guam Industrial Fair, held at Agana July 3, 4, and 5, 1919, of copra showing samples from each of the above experiments. Placards explaining each of the tests and the results were placed with the samples. It is planned to include the data of these experiments in more detailed form in a publication to be issued by the station in the near future.

BANANAS.

Banana trees throughout the island were nearly all blown down and uprooted by the typhoon, but in most cases the suckers and stumps were planted immediately and toward the end of the year some plants had already blossomed and fruits were setting. The demand for suckers from this station has been met as far as possible

with the Lacatan variety which is one of the best varieties of the improved type adapted to Guam. Velvet beans and cowpeas have both made very efficient cover crops in the banana plantation.

COFFEE.

Coffee investigations have been carried on at this station for some time, but the work for the last two years has resulted in failures because of soil or other conditions. The soil where the crop was tested has been classed as a dark loam underlain by clay. It is only a few feet above sea level, though in other places on the island, where perhaps the soil is more sandy, coffee grows well at the same altitude. Some new plantings have been started by farmers and by the island government in more favorable locations, but in general the farmers show little interest in growing the crop on a commercial scale.

REPORT OF THE EXTENSION AGENT.

By W. J. GREEN.

INTRODUCTION.

From the time of its establishment, the experiment station has done considerable extension work by distributing seeds and plants, encouraging the introduction and adoption of modern farm implements, providing pure-bred and high-grade animals to be used for breeding purposes, and by distributing eggs of improved strains of chickens, but it was impossible to give this work the close personal supervision in the field that is required by the average native farmer. For this reason it was decided to form a department of the station devoted especially to extension work.

The extension agent was appointed on January 25, 1919, and arrived at the station on March 28, 1919, the greater part of the intervening time being spent in traveling to Guam.

After reviewing the situation, the extension agent decided to organize extension work covering three general lines: Adult demonstrations, boys' and girls' club work, and school gardens. This report must be concerned mainly with an outline of what is being done, as too short a time has elapsed since the starting of the work for any definite results to be observed.

The island of Guam is located in latitude 13° north and in longitude 144° east. Apra harbor, its only port, is 1,506 miles east of Manila, 3,337 miles southwest of Honolulu, and 5,053 miles from San Francisco.

The island of Guam is about 30 miles in length and from 4 to 8 miles in width. The estimated area is 225 square miles. Not more than one-fourth of the land is under cultivation.

FARMING CONDITIONS IN GUAM.

The northern part of the island is a high plateau broken by only three hills, while the southern half is for the most part rough and hilly. The best crops are grown on the lowland near the seashore and in the small valleys among the hills. The northern half of the island, except where the land has been cleared for planting, is covered with tropical forests. The uplands and hillsides of the southern part have very little vegetation other than sword grass (*Miscanthus floridulus*), locally known as neti. These regions are called savannas, and, except for grazing, are little used for farming purposes. The two parts of the island have still other points of difference. The soil of the north is more porous than that of the south but is underlain by an impervious subsoil of "cascajo," or disintegrated coral, to a depth ranging from 8 inches to 4 feet. The south end is for the most part well watered with many streams, but on the high plateau of the north the soil is so porous that the water disappears as it falls, and as a result no streams are found.

The climate is tropical in nature but is tempered during the greater part of the year by the northeast trade wind. On an average, the temperature ranges from 70° to 95° F. Like other tropical countries Guam has two seasons, the rainy and the dry. The rainy season usually begins in June and lasts until November. The dry season extends from January to May. The seasons do not begin and end abruptly but often gradually merge into one another.

Guam is under naval government. The governor, who is a naval officer, is appointed by the Secretary of the Navy. The greater part of the island government offices are filled by Navy and marine officers. For administrative purposes the island is divided into 15 districts. A patrolman, an enlisted man of the Marine Corps, is generally stationed in each district to preserve order and to assist the people on their ranches by giving advice in regard to their farming operations. Eleven of the districts have schools and one more school is soon to be put into operation. Each district also has a commissioner or deputy commissioner, a native appointed by the governor to act as his representative in dealing with the people.

The Guam Agricultural Experiment Station was established in 1908 and is located near the village of Piti. A tract of land of about 1,200 acres was purchased in 1915 for the purpose of establishing a stock farm. This place, known as the Cotot stock farm, is located in the interior of the island, some 10 miles from the station in the district of Yona.

The inhabitants of the island are called Chamorros, although the present population is mixed with Filipino, Spanish, and to some extent with Japanese, Chinese, Mexican, and American blood. While the universal language is Chamorro, some of the older people

speak Spanish and most of the younger generation can talk in English.

With the exception of a few large plantations, most of the farms are very small, consisting of only a few acres. These holdings are known as ranches. Practically every family has a ranch of some kind, even though the head of the family owns a store, follows some trade, or works for the government.

Nearly 60 per cent of the inhabitants of the island live in Agana, the capital. Most of the others have their houses in towns and villages scattered over the island. Very few of them live on their farms, for they follow the Spanish custom of having their homes in town and going out to their ranches to work. This practice consumes much time and means that less work is accomplished than where the people live in the country.

Copra is the chief money crop of the island and the only article of export. Corn is the principal cereal crop and is grown in all parts of the island under cultivation. Rice is planted on the lowlands near Piti and in the southern part of the island. Owing to insect damage the production of this crop has greatly decreased during the past few years. The root crops include taro, sweet potatoes, yams, cassava, and arrowroot. The principal fruits are bananas, lemons, limes, oranges, mangoes, alligator pears, pineapples, sweet and sour sops, and breadfruit. Beans, eggplants, peppers, watermelons, muskmelons, pepinoes, cucumbers, and a few tomatoes are produced in the gardens. Considerable coffee is grown in some parts of the island but it is not produced in sufficient quantities for export. Some cacao is also produced but not nearly enough for local use.

Guam has no seed merchants. All the seed that is used has been saved by the people or distributed to them by the station. The two planting seasons are just before and immediately after the rainy season. The latter planting usually produces the better crops.

The methods of working the land are very primitive. In most cases all of the work is done by hand. The two important farm tools are the machete and the fosiño. The former is a wide-bladed knife, 10 to 14 inches long, which takes the place of an ax, a pocket-knife, a sickle, a scythe, a saw, and in many cases, a hammer. It is carried in a leather scabbard strapped to the owner's side. The fosiño resembles a shuffle hoe. It is a T-shaped tool having a hollow socket into which is fitted a long, wooden handle. This tool is used for clearing the land of weeds and grass, planting the seed, and cultivating the crop. It takes the place of a hoe, spade, plow, cultivator, and harrow.

A few of the most progressive farmers use plows. A small one-handled steel plow, similar to that used in the Philippines, is taking the place of the crude wooden plow formerly used. A small num-

ber of 5-shovel cultivators are also owned by the natives. These implements were introduced largely through the influence of the experiment station. They are drawn by cattle or carabao. As the plow turns a 4 or 6 inch furrow, considerable time is consumed in working the land. On an average it takes about six days to plow 1 acre.

Cattle and carabao are the all-purpose animals. They are used for driving and riding, for meat, and in some cases for milking. The carabao, or water-buffalo, is heavier and stronger than a bullock, but can not endure as much heat as the latter. The carabao is the only animal used in working the flooded rice fields. Most of the animals when not working are kept tied with a rope, for there are very few fenced pastures. The largest bulls are castrated and used as work animals, while the smaller ones are left for breeding purposes. This practice has been a great hindrance to live-stock development. The native cattle are not only small in size but poor milk producers.

The few native-owned horses on the island are small Philippine ponies, which are used for riding and sometimes for driving, but never for farm work.

The native pigs are of two general types. The "chabot" is a chunky, fine-boned lard type animal, while the "lanza" is a comparatively long, rangy, bacon-type hog. Practically all the pigs are kept with a rope secured to one foot. Pens, even of the smallest sizes, are seldom used.

Some of the natives keep goats for meat. These animals are seldom used for milking.

Most of the families have at least a few chickens. Except where eggs have been secured from the station the fowls are of an inferior type, small in size and badly mixed. Some of the natives take more interest in raising birds for cock-fighting than for meat or eggs. Poultry houses and coops for housing the chickens are practically unknown.

The time is now ripe for starting extension work on the island. The experiment station has clearly demonstrated the fact that a greater number and variety of products can be produced on the ranches by the planting of better seed, the adoption of modern methods of tillage, the more practical care of live stock and poultry, and the improvement of the farm animals by breeding to pure-bred or high-grade sires. It now is necessary to get these facts to farmers in such a way that they will readily understand and make use of them.

ADULT DEMONSTRATION WORK.

This phase of the work is being conducted with the cooperation of the insular patrol. An arrangement has been made with the Governor of Guam whereby each patrolman will assist with the adult demonstration work in his district.

The plan of the adult demonstration work is to select in each district a number of men who will conduct demonstrations in growing certain crops, or in raising certain kinds of live stock. The best farmers in each district are selected as demonstrators. If a man is a good corn grower, he is asked to plant and care for a plat of corn according to the directions and suggestions given by the experiment station. This plat will serve to demonstrate to his neighbors what can be done by the pursuit of proper methods of seed selection, seed-bed preparation, planting, and cultivation.

Demonstrators have been selected for growing corn, bananas, coffee, cacao, tobacco, rice, taro, and garden vegetables; for raising hogs, cattle, horses, goats, poultry, and bees; and for making copra. It is planned to start other demonstrations from time to time, as needed.

Only a small portion of a man's ranch need be used for demonstration purposes, though the entire area may be used if the owner so desires. A man may conduct more than one demonstration. For instance, he may have one demonstration plat of corn and another of taro, and may conduct a third demonstration by feeding a hog according to instructions.

It is planned to hold field meetings during the year on the farms of the best demonstrators so that the people of the community can be shown the actual results of using better methods of farming. The demonstration work is based on the fact that a man will learn more by being shown than by being told.

Personal visits are made to the ranches of the demonstrators as often as possible. These visits are absolutely necessary, for the Chamorro farmer is slow to adopt new methods, and, even after making a start, is likely to fall back into his accustomed ways of doing things.

In order to arouse a competitive spirit among the farmers, each demonstrator is urged to make an exhibit at the Guam Industrial Fair.

SCHOOL GARDENS.

School gardens have been grown in connection with each of the schools of the island for a number of years. These gardens serve to get the school children interested in growing food crops and have proved very valuable. The teachers, however, had so little agricultural training and knew so little about modern methods of farming that they were unable to give as much instruction along this line as otherwise might have been given.

An arrangement has been made whereby in the future these gardens will be handled cooperatively by the experiment stations and the department of education. According to this plan the extension agent will have supervision of the planting and care of the gardens.

It is planned to make these gardens serve as demonstrations to the farmers of the various districts as to what can be done by the use of proper methods for the growing of vegetables. They will also serve to give the younger generation some excellent training which will be of value to them later in life.

BOYS' AND GIRLS' CLUB WORK.

Boys' and girls' agricultural clubs are being organized in Guam for the following purposes:

(1) To teach the boys and girls the principles of modern agriculture by having them do some definite work at home under proper supervision.

(2) To bring the school life of the boy and girl in closer touch with the home life.

(3) To furnish an organized means of effecting a permanent improvement in the agriculture of the island.

(4) To enlarge the vision of the boy and girl by putting them in touch with what is being done in other places.

(5) To make better citizens by giving the future men and women a definite purpose in life.

The club work was started in May and includes corn, copra, bean, taro, pig, and poultry production. It was thought that work in these activities would be the most beneficial to the island. The chief grain crop of the island is corn; copra is the principal money crop and practically the only article of export; beans are grown on every farm for food; taro is an important crop in case of a typhoon when other food crops are destroyed; and pig and poultry raising are important industries that need developing.

This work is conducted largely through the schools of the island. A teacher in each district is appointed supervisor and is held responsible for the work in his community. The supervisor visits the members in their homes and on their farms and reports their progress to the extension agent. A meeting is held with the supervisors every two weeks in Agana. At these meetings reports are made, and the teachers are given further suggestions and instructions for carrying on the work. So far clubs have been organized in each of the outlying districts in which schools are located.

The following rules have been drawn up for the club work:

(1) Any boy or girl under 18 years of age may become a member by enrolling and agreeing to follow instructions.

(2) Instructions must be followed as closely as possible.

(3) A report of the season's work must be made out on the blanks provided for that purpose, and submitted with a story of how the member carried on his work.

(4) Each member must make an exhibit at a local contest and at the Guam Industrial Fair.

(5) A corn club member must grow at least one-tenth acre of corn.

(6) A copra club member must care for at least 10 coconut trees and make copra from the nuts obtained.

(7) A bean club member must plant and care for a plat of beans of at least 500 square feet.

(8) A taro club member must plant and care for a plat of taro measuring at least 500 square feet.

(9) A pig club member must care for at least one pig according to instructions.

(10) Each poultry club member must set at least 10 eggs and care for the chicks that are hatched.

Printed instructions for each of the club activities are issued to the members each month. These instructions are written in short sentence form and in simple language so that they can be understood by the boys and girls.

The printed instructions are supplemented by personal visits to the demonstration plats and animals. On these visits the extension agent is accompanied by the supervisor and members of the local club. The work of each boy and girl is inspected and a discussion is held as to how it might be improved.

The following table gives the enrollment by districts and by activities:

Enrollment of boys' and girls' clubs, July 1, 1919.

District.	Project and number of members enrolled.						
	Corn.	Copra.	Bean.	Taro.	Pig.	Poultry.	Total.
Agat.....	13	2	9	1	25	44	94
Asan.....	9	3	12	3	6	18	51
Dededo.....	5	2	5	3	3	9	27
Inarajan.....	5	1	21	1	1	1	30
Merizo.....	10	5	12	4	9	7	47
Piti.....	9	3	19	6	33	66	136
Sumay.....	19	.....	10	7	1	8	45
Umatac.....	5	.....	5	5	5	20	40
Yigo.....	6	.....	2	2	2	2	14
Yona.....	6	.....	3	.....	.....	6	15
Total.....	87	16	98	32	85	181	499

METEOROLOGICAL OBSERVATIONS, 1919.

By P. NELSON, *Assistant.*

The meteorological observations which were commenced at the beginning of the fiscal year 1918, were continued during the fiscal year 1919.

This year was marked in that the island was visited by the severest typhoon since the one that devastated the island in November, 1900.

Early in July the barometer was unsteady and below normal. About 4 a. m. July 6, the barometer began falling rapidly, and by 5.30 a. m. a gale was blowing from a westerly direction and increased in force until about 7.30 a. m., when the characteristic dead calm

took place. About 8.30 a. m. the wind changed to a southerly direction and continued until 10.30 a. m. The second period was much the more severe, and during this interval the anemometer mounted at the station was blown down and the instrument destroyed. As a result no record of the velocity of the wind was recorded. A report received from the cable station located at Sumay, stated that the anemometer at that place had registered a velocity of 125 miles per hour. The shelter containing the thermometers was blown over and the instruments were broken. The lowest reading of the mercurial barometer at the station was noted at 28.19 inches, and an aneroid barometer at the beachmaster's office, Piti, registered 28.17 inches. As usual, the typhoon was accompanied by a heavy rainfall, and up to 4 p. m. a precipitation of 10.5 inches was recorded, this being the maximum daily rainfall for the entire year. A heavy downpour continued on the day following the storm, and 7.68 inches were recorded. The storm visited the entire island in varying degrees of intensity and did considerable damage to crops, destroyed many of the native houses, uprooted trees, and blocked traffic. Old residents concede that this storm was the severest one that has swept the island since 1900.

On September 17 and 18 the barometer was very unsteady, dropping to 29.409 inches at 3 a. m. on the 18th, and remaining there until 4.30 a. m. During this interval very heavy wind and rain squalls swept over the island, and at times these squalls had apparently the same force as those experienced in the typhoon of July.

On June 29 a typhoon was reported by the Manila observatory to be passing about 200 miles to the south. The effects of this storm were felt in that the barometer dropped below normal for several days and frequent squalls swept over the island.

Atmospheric pressure.—The regular barometer readings were taken at 4 p. m. daily. The highest reading for the year was 30.748 inches, recorded in April, and the lowest, 28.19 inches, recorded July 6, 1918, the date of the typhoon. The annual average for the monthly means was 29.805 inches.

Temperature.—The absolute maximum temperature for the year, 99° F., was recorded on May 4 and the absolute minimum, 69°, March 8. The averages of monthly means were maximum, 89.09° F.; and minimum, 74.78° F. The greatest daily range, 23°, occurred May 4, and the lowest range, 6° was recorded May 28. A temperature of 90° or over was observed on 143 days during the year.

The dry and wet bulb thermometers were broken during the typhoon and were not replaced and put in operation until February 7.

Velocity and direction of wind.—The pole upon which the anemometer was mounted was blown down and the anemometer destroyed during the storm of July 6. A new pole was erected and the repaired anemometer put in operation on October 22. The record for the year, therefore, covers a period of a little more than eight months.

The average of monthly means for this period was 181.90 miles, daily average velocity, and 7.57 miles, hourly average velocity. The prevailing direction of the wind during the year was northeast, with 48 per cent of the total observations east, southeast, north, west, and south, ranking in the order named.

Rainfall.—The total precipitation recorded for the year amounted to 95.77 inches, 5.45 inches less than during the previous year. July proved the wettest month with a total of 30.53 inches, and April the driest with 0.61 inch. The maximum daily precipitation of 10.5 inches occurred on July 6. Rainfall was recorded during every month of the year; July had the maximum number of rainy days, with a total of 28 days, and April the minimum, with 13 days. The period from July to December proved to be the wet season, and had 153 days with a total rainfall of 81.61 inches. From January to June, the dry season had 99 days of rainfall, with a total of 14.16 inches.

The following tables give summaries of meteorological data collected within the year, and compare the rainfall of the 2 years covered by this and the previous reports and the average for the past 14 years:

Condensed meteorological data for the fiscal year 1919.

Month.	Temperature.					Relative humidity (monthly mean). ¹	Total precipitation.	Wind. ¹	
	Maximum.	Minimum.	Mean maximum.	Mean minimum.	Monthly mean.			Prevailing direction.	Average hourly velocity.
1918.	° F.	° F.	° F.	° F.	° F.	Per cent.	Inches.		Miles.
July.....	92.0	70.0	87.91	74.51	81.21	.....	30.53	.....	.....
August.....	92.0	72.0	88.55	75.63	82.09	.....	12.27	.....	.....
September.....	91.0	71.5	87.33	75.23	81.28	.....	16.90	.....	.....
October....	97.0	73.0	88.53	74.97	81.75	.....	12.60	NE.	6.19
November....	95.0	70.0	90.13	74.16	82.15	.....	6.26	NE.	6.80
December..	97.5	70.5	89.61	74.03	81.82	.....	3.05	NE.	8.87
1919.									
January...	92.0	69.0	89.61	72.51	81.06	.....	1.65	NE.	8.08
February..	93.5	69.5	89.71	72.91	81.31	78.22	0.91	NE.	8.73
March.....	96.0	69.0	90.19	73.48	81.83	72.70	1.42	NE.	9.39
April.....	92.0	72.5	89.25	75.53	82.39	71.43	0.61	NE.	6.59
May.....	99.0	74.0	89.38	77.35	83.37	74.16	1.03	E.	7.73
June.....	92.5	73.0	88.91	77.13	83.02	81.10	8.54	E.	5.78

¹ Dry and wet bulb thermometers broken and anemometer mounting blown down during typhoon of July 6, new instruments received and put in operation Feb. 7 and Oct. 6, respectively.

Comparison of rainfall by months.

Month.	1917-18	1918-19	Average for 2 years.	Average for 14 years. ¹	Month.	1917-18	1918-19	Average for 2 years.	Average for 14 years. ¹
	Inches.	Inches.	Inches.	Inches.		Inches.	Inches.	Inches.	Inches.
July.....	8.95	30.53	19.740	13.59	February.....	8.53	0.91	4.720	3.06
August.....	15.13	12.27	13.700	14.75	March.....	2.67	1.42	2.045	2.93
September.....	20.94	16.90	18.920	16.90	April.....	3.65	0.61	2.130	1.72
October.....	11.71	12.60	12.155	13.76	May.....	5.10	1.03	3.065	3.81
November.....	6.29	6.26	6.275	8.25	June.....	8.05	8.54	8.295	5.06
December.....	2.58	3.05	2.815	5.48					
January.....	7.62	1.65	4.635	2.55	Total.....	101.22	95.77	98.495	91.86

¹ Data obtained from records of Commercial Pacific Cable Co.



